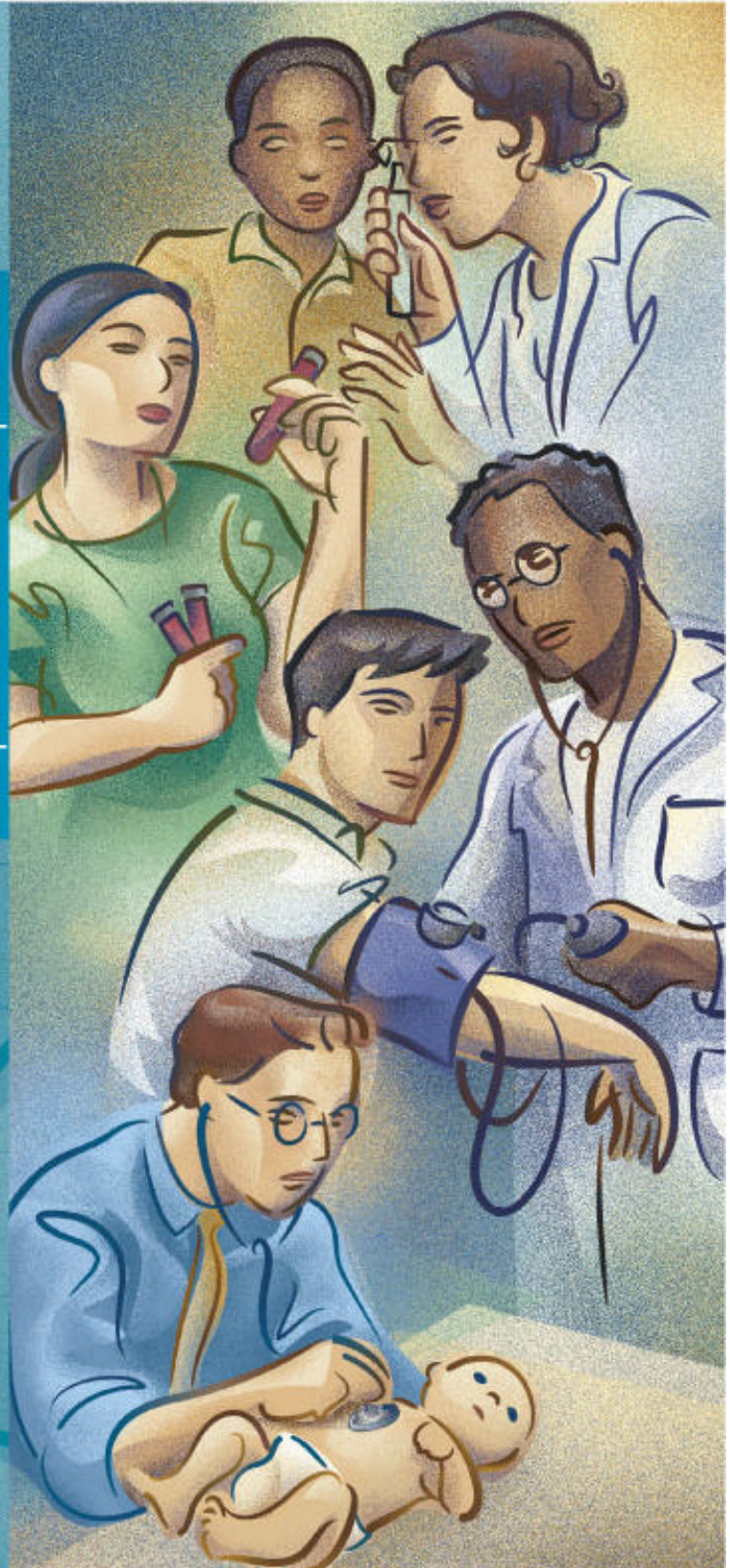




AHRQ QUALITY INDICATORS

# Prevention Quality Indicators

SOFTWARE DOCUMENTATION



**AHRQ Quality Indicators**

**Prevention Quality Indicators:  
Software Documentation, Version 2.1 – 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 about 16 Prevention Quality Indicators (PQIs): avoidable *hospitalizations and ambulatory care sensitive condition (ACSC)* indicators, which involve admissions that evidence suggest could have been avoided, at least in part, through better access to high-quality outpatient care.

This document is the software documentation for the Prevention Quality 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 Prevention Quality Indicators can be found in “Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions.”

## Acknowledgments

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## Table of Contents

<b>Abstract</b> .....	<b>i</b>
<b>Acknowledgments</b> .....	<b>ii</b>
<b>Introduction</b> .....	<b>1</b>
<b>Components of the Prevention Quality Indicators module</b> .....	<b>1</b>
<b>Quick Reference</b> .....	<b>2</b>
Figure 1. Processing Steps .....	3
Prevention Quality Indicator Module Details .....	4
<b>Background</b> .....	<b>5</b>
<b>Data elements and coding conventions</b> .....	<b>6</b>
Input for the AHRQ Quality Indicators.....	6
Coding of diagnoses, procedures, and DRGs .....	8
Missing values.....	8
<b>User options</b> .....	<b>9</b>
<b>Processing steps</b> .....	<b>10</b>
1. Identify outcomes in inpatient records .....	10
2. Identify populations at risk from Census population data .....	10
3. Calculate observed (raw) Prevention Quality Indicator rates .....	10
4. Risk adjust the Prevention Quality Indicator rates .....	10
5. Create MSX smoothed rates.....	11
<b>Program descriptions</b> .....	<b>12</b>
Program 1: modify statements in the CONTROL.SAS code .....	12
Program 2: run PQFMTS .....	13
Program 3: run PQSASA1 .....	14
Program 4: run PQSASA2 .....	15
Program 5: run PQSASA3 (optional) .....	17
<b>Reviewing the printed output.</b> .....	<b>19</b>
PQSASA1 .....	19
PQSASA2 .....	19
PQSASA3 .....	20
<b>Interpreting the results.</b> .....	<b>21</b>
Observed means.....	21
Risk-adjusted rates .....	21
MSX smoothed rates.....	22
Comparing observed, risk-adjusted and smoothed rates .....	23
<b>Benchmark timings</b> .....	<b>24</b>
<b>User Support</b> .....	<b>25</b>

## List of Tables

Table 1. Prevention Quality Indicator (PQI) Variables.....	4
Table 2. Prefixes for the Prevention Quality Indicator (PQI) Variables .....	4
Table 3. Prevention Quality Module Contents .....	4
Table 4. Data Elements and Coding Conventions.....	7
Table 5. PQSASA2 aggregation possibilities.....	16

# AHRQ Quality Indicators, Software Documentation, Version 2.1: Prevention Quality Indicators

## Introduction

This documentation describes the software for implementing the Prevention Quality Indicator (PQI) 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 Prevention Quality Indicators (PQI) is contained in the companion document “*Guide to the Prevention Quality 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 PQIs from hospital discharge abstracts or UB (uniform billing) claims data.
- ▶ Print PQI 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 casemix differences.
- ▶ Create smoothed rates that reduce fluctuations over time due to random variation.

This documentation includes:

- ▶ A discussion of the data elements necessary to produce the AHRQ PQIs and the uniform coding conventions recommended for those elements.
- ▶ Descriptions of the PQI processing steps in nontechnical language.
- ▶ Detailed descriptions of the functions of each PQI SAS program.

***Critical user information is highlighted with this symbol:*** 

## Components of the Prevention Quality Indicators module

As shown in Table 3 on page 4, the Prevention Quality Indicators module consists of five SAS programs and nine 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.

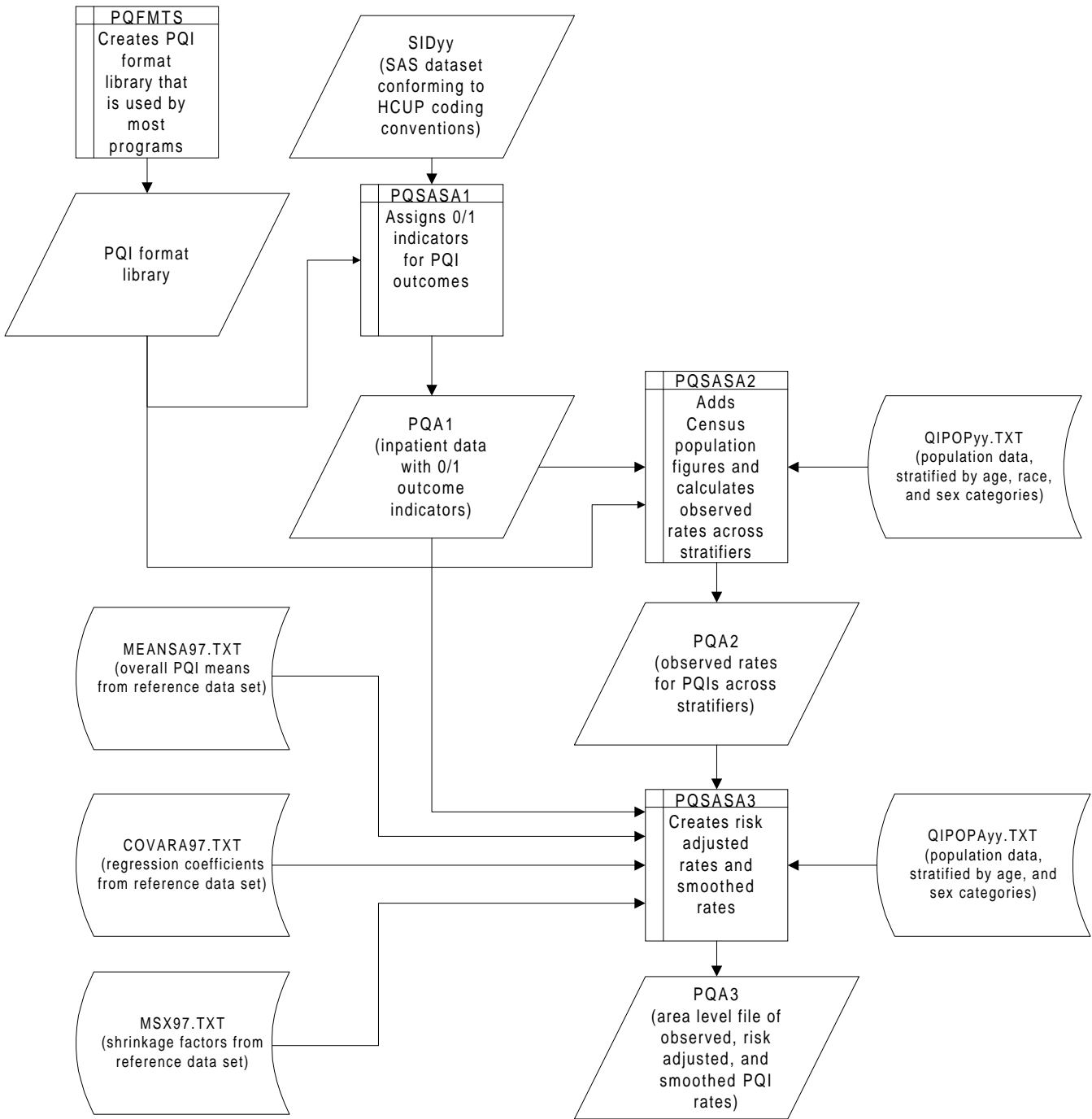
A note on the naming conventions for the Prevention Quality Indicators (PQI) module programs. The programs have names of the form PQSAS*i*. The first two characters “PQ” of the program name indicates a Prevention Quality Indicators program, to distinguish it from other modules that are forthcoming from 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. The sixth character of the program name is always “A” to denote a program that is for the production of Area indicator rates that use county and Metropolitan Statistical Area (MSA) area populations as denominators. Future modules will generate indicators that use as denominators subsets of the hospitalized population. The last character (i) designates the number of the specific program.

## Quick Reference

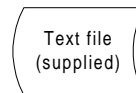
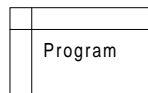
The subsequent two pages are intended to serve as a quick reference to assist in reading this documentation and in reviewing the Prevention Quality Indicator (PQI) module outputs. Processing steps (Figure 1) are shown first followed by a listing of the module variables (Table 1), variable prefixes (Table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



**Figure 1. Processing Steps**



**LEGEND:**



## Prevention Quality Indicator Module Details

Indicator number	Numerator (admissions for ACSC)	Denominator	Age categories			
			0 to 17	18 to 39	40 to 64	65 +
1	Diabetes short term cx	Area population		Included	Included	Included
2	Perforated appendix	<b>Appendicitis*</b>	Included	Included	Included	Included
3	Diabetes long term cx	Area population		Included	Included	Included
4	Pediatric asthma	Area population	Included			
5	COPD	Area population		Included	Included	Included
6	Pediatric gastroenteritis	Area population	Included			
7	Hypertension	Area population		Included	Included	Included
8	CHF	Area population		Included	Included	Included
9	Low birth weight	<b>Births*</b>	NA	NA	NA	NA
10	Dehydration	Area population	Included	Included	Included	Included
11	Bacterial pneumonia	Area population	Included	Included	Included	Included
12	Urinary infection	Area population	Included	Included	Included	Included
13	Angina w/o procedures	Area population		Included	Included	Included
14	Diabetes uncontrolled	Area population		Included	Included	Included
15	Adult asthma	Area population		Included	Included	Included
16	Lower extremity amputation, DM	Area population		Included	Included	Included

ACSC – Ambulatory Care Sensitive Condition.

\* The denominator includes all hospital admissions for this condition in the area.

Prefix	Contents	Example (for PQI # 1, Diabetes short-term complications)
T	Inpatient numerator (top)	TAPQ01
P	Population denominator (pop)	PAPQ01
O	Observed Rate	OAPQ01
R	Risk-adjusted Rate	RAPQ01
S	Smoothed Rate	SAPQ01

SAS programs	ASCII text files †
CONTROL.SAS	QIPOP97.TXT
PQFMTS.SAS	QIPOP98.TXT
PQSASA1.SAS	QIPOP99.TXT
PQSASA2.SAS	QIPOPA97.TXT
PQSASA3.SAS	QIPOPA98.TXT
	QIPOPA99.TXT
	MEANSA97.TXT
	COVARA97.TXT
	MSX97.TXT

† The ASCII text files are provided with the Prevention Quality module, and are necessary for the programs to run.

## Background

The PQI module contains 16 indicators that measure hospital admissions for ambulatory care sensitive conditions (ACSC) across geographic areas. ACSCs represent conditions for which hospitalization could be avoided if the patient receives timely and adequate outpatient care. Many factors influence the quality of outpatient care, including access to care and adequately prescribed treatments, once care is obtained. In addition, patient compliance with those treatments and other patient factors may play a role. In general, areas with lower social-economic status tend to have higher admission rates for ACSCs than areas with higher social-economic status. As with utilization indicators, there are no “right rates” of admission for these conditions. Very low rates could signal inappropriate underutilization of healthcare resources while very high rates could indicate potential overuse of inpatient care.

Therefore, hospital admission for ACSCs is not a measure of hospital quality but a potential indicator of outpatient and community health care need. For example, if an area has a relatively high hospital admission rate for diabetes complications, the local healthcare providers should work with the community to identify reasons and strategies to address the problem.

The 16 ACSCs in the PQI module are listed in Table 1 on page 4. See Appendix A of the “*Guide to the Prevention Quality Indicators*” for the definition of each indicator.

Except for perforated appendix and low birth weight, each indicator is measured as the number of hospital admissions for a particular ACSC per 100,000 residential population in an area. Geographic areas are defined at the MSA (Metropolitan Statistical Area) level for urban areas and at the county level for rural areas.

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 are from the Bureau of Census.

The software generates observed, risk-adjusted, and smoothed rates for each indicator at the area level. Observed rates are the raw rates. Risk-adjusted rates are derived from applying the average casemix of a baseline file that reflects a large proportion of the U.S. population to the areas’ observed rates. Smoothed rates are estimates with removal of fluctuations over time due to random variation.

For information about how these indicators were identified, see the “*Guide to the Prevention Quality Indicators*.”


## Data elements and coding conventions

### *Input for the AHRQ Quality Indicators*

The PQI 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 PQI software are listed in Table 4. The PQI 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 Prevention Quality Indicators software must be in SAS.*


For ease of use, the input data file should contain a specific set of variables coded in specific ways. For example, the PQI software expects a numeric data element named SEX with values coded 1 for male and 2 for female.

 *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 Prevention Quality Indicators software.*

For example, recoding the SEX data element in the input file to be consistent with the coding described above is easier than modifying all uses of the SEX data element in the PQI programs.

Input data elements, their characteristics, and values expected by the software are described in Table 4. Not every value for every data element is referenced by the PQI software. For example, admission source (ASOURCE) values are used only to identify transfers. However, we include the complete set of HCUP values to assist users of the uniform HCUP data files.

Two of the data elements, KEY and HOSPID, are included only for convenience. They are not used directly in the software to define a measure or a stratifier.


 *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 PQI programs.*


**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	Optional
AGE	Age in years at admission	Numeric	Age in years	
RACE	Race of patient.	Numeric 1 2 3 4 5 6	White Black Hispanic Asian or Pacific Island Native American other	
SEX	Sex of patient	Numeric 1 2	Male Female	
HOSPSTCO	Hospital location (FIPS <sup>†</sup> State/county code)	Numeric ssccc	Modified Federal Information Processing Standards State/county code	Available at: <a href="http://www.census.gov/population/estimates/fips.txt">http://www.census.gov/population/estimates/fips.txt</a>
HOSPID	Data Source hospital number	Numeric	Hospital identification number	Optional
ASOURCE	Admission Source	Numeric 1 2 3 4 5	ER Another hospital Another fac. incl. LTC court/law enforcement routine/birth/other	
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	
DRG	Diagnosis Related Group	Numeric	DRG from federal DRG Grouper	
MDC	Major Diagnostic Category	Numeric	MDC from federal DRG grouper	
DX1 – DX5	Diagnoses ICD-9-CM codes. DX1 is the principal diagnosis, DX2-DX5 are secondary diagnoses.	String, 5 character	Diagnoses code	Users with more or fewer secondary diagnoses should modify the parameter &NDX in CONTROL.SAS to reflect the number of diagnoses.
PR1 – PR4	Procedure ICD-9-CM codes. PR1 is the principal diagnosis, PR2-PR4 are secondary procedures.	String, 4 character	Procedure code	Users with more or fewer secondary procedures should modify the parameter &NPR in CONTROL.SAS to reflect the number of diagnoses.


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

## **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. PQI definitions only reflect codes valid after October 1, 1994, and therefore may not accurately analyze data collected before 1994.*

- ◆ 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.
- ◆ This software has ICD-9-CM codes updated through FY2001 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, 2001.*


## **Missing values**

 *The PQI 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 PQI programs do **not** distinguish among the different types of missing codes. Therefore, all types of missing values in the input data to the PQI module can be represented by a single value - missing data (.) for numeric variables and blank (' ') for alphanumeric (or character) variables.

## User options

The PQI software reflects the development and implementation of the software in 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 PQI software to better serve their local conditions or interests.

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

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

## Processing steps

Each Prevention Quality Indicator (PQI) expressed as a rate, is simply defined as:

Outcome of interest / Population at risk.

Conceptually, five steps are necessary to produce the PQI 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 PQI measures.

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


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

### **2. Identify populations at risk from Census population data**

The populations at risk (the denominators for calculating the PQI rates) are derived from Census population figures.

### **3. Calculate observed (raw) Prevention Quality Indicator rates**

Using the output data from step 1 and Census population data from step 2, the PQI rates are calculated for user-specified combinations of stratifiers. These stratifiers include area (MSA/county), age groups, race/ethnicity categories, and sex.

 *The programs calculate PQI rates regardless of the number of cases available. However, 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 to user-specified levels by area (MSA/county), age, sex, and race/ethnicity categories, alone or in combination. For example, rates can be output at the area level, at the age group level, or at the area level by age groups.

### **4. Risk adjust the Prevention Quality Indicator rates.**

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 to risk-adjust the rates observed in the user’s data. The risk-adjusted rates will then reflect the age and sex distribution of areas in the baseline file rather than the distribution for the areas covered by 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 AHRQ’s State Inpatient Databases (SID) for



19 states. The codes to generate these baseline means and coefficients are not part of the PQI module.

## **5. *Create MSX smoothed rates.***

Shrinkage factors are applied to the risk-adjusted rates for each PQI in a process called multivariate signal extraction (MSX). These shrinkage factors were calculated from the SID database of 19 states. For each PQI, the shrinkage estimate reflects a 'reliability adjustment' unique to each indicator. The less reliable the PQI over time and across areas, the more the estimate 'shrinks' the PQI toward the overall area 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 PQI software and do not need to be calculated by users.

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

## Program descriptions


This section describes the five SAS programs that assign, calculate, and print the Prevention Quality 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 PQI module programs is shown in the flowchart in Figure 1 of page 3.

If you desire to create and examine observed PQI rates, then the PQFMTS, CONTROL, PQSASA1, and PQSASA2 programs will need to be used. If you also wish to create risk-adjusted and smoothed PQI rates, then you will also need to run the PQSASA3 program.

### ***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 PQI 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 PQSASA1, PQSASA2, and PQSASA3 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.*

 *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 PQI 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.

## ***Program 2: run PQFMTS***

The PQFMTS 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). These are followed by formats that are used for the identification of outcomes of interest in the PQSASA1 program, and by formats that map FIPS county codes to metropolitan statistical areas (MSAs) in the PQSASA1 and PQSASA2 programs. At the end of the programs are formats used to assign age categories for the risk adjustment process implemented in PQSASA3.

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 PQI module version 2.1 contains formats that incorporate ICD-9-CM and DRG coding through September 30, 2001.

Input: None.

Output: Permanent SAS format library (FMTLIB).

Changes: 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.

### ***Program 3: run PQSASA1***

The PQSASA1 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 7 for variable names and attributes for the input data file.

Partial definitions of the Prevention Quality Indicators are given in Table 1 on page 4. 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 the Prevention Quality Indicators*".

#### 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 PQFMT program.

#### Output:

1. SAS dataset containing inpatient records with input variables, stratifiers, and flag indicators (TAPQxx) for the outcomes of interest that will later form the numerators for the PQI 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.

#### 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 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 PQI module assumes that your starting SAS data set contains 5 diagnoses, and 4 procedures. If these numbers are different in your input inpatient data, then modify the NDX and NPR parameters in CONTROL.SAS.

## ***Program 4: run PQSASA2***

The PQSASA2 program calculates the observed or raw rates for the area-level Prevention Quality Indicators, using the data derived in the previous step (PQSASA1). These observed rates are stratified by combinations of area, sex, age, and race categories. The program first totals the indicator flags created by the previous 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 previous step (PQSASA1). This is a discharge-level file that contains inpatient records with input variables, stratifiers, and the 16 new flag indicators for the PQI outcomes of interest.
2. A text file with Census area residential populations, stratified by area, age, sex, and ethnicity categories. Three such files are currently provided along with the PQI module software. The files are QIPOP97, QIPOP98, and QIPOP99. 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 PQFMT program.


### Output:


1. SAS dataset with summary records that contain observed rates (OAPQxx variables where xx refers to the indicator number), the counts of outcomes that formed the numerators of the rates (TAPQxx variables), and the residential population totals that formed the denominators of the observed rates (PAPQxx variables). The output file has records summarized to the various combinations of stratifiers specified in the TYPELEVL parameter that is described in change #5 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 OAPQxx observed rates, the TAPQxx counts of outcomes that formed the numerators of the rates, and the PAPQxx residential population totals. The different records/rows in the text file will correspond to the different TYPELEVL stratification combinations.
3. PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of all of the numeric variables in the output data file and a PROC PRINT of the output data file are 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.SAS code.
2. In CONTROL.SAS, specify the locations (paths) of the input and output SAS files in the "LIBNAME IN2" and "LIBNAME OUT2" statements.
3. In CONTROL.SAS, specify the names of the input and output files in the "INFILE2" and "OUTFILE2" statements. The name that you specify with INFILE2 should be for the file that you created using the previous PQSASA1 program.
4. In CONTROL.SAS, specify the path (including the file name) for the ASCII population text file in the "FILENAME POPFILE2" statement. The file name will be QIPOP97.TXT or QIPOP98.TXT or QIPOP99.TXT. These files are provided to you as part of the PQI module. The file used should be the one that is closest to the year associated with your particular data.

- 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 TYPELEVL =” statement. Each number from 0 to 15 corresponds to a different level or combination of levels as show in Table 5. The default values of 0, 8, 9, 10, 12 will provide an overall total, area-level totals, and totals at the area level for age, sex, or race.

 **WARNING:** TYPELEVL must include the values 0 (overall) and 8 (area) if you wish to subsequently run program PQSASA3 for risk-adjusted and smoothed rates.

 If TYPELEVL 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 PQSASA1 program.

TYPELEVL	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

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

- 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.
- 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 PQTEXTA2” statement.

## ***Program 5: run PQSASA3 (optional)***

The PQSASA3 program calculates age and sex risk-adjusted rates for each PQI (overall rates and rates by area), and then calculates smoothed rates.

### Input:

1. SAS format library (FMTLIB) created from the PQFMT program.
2. The discharge-level file that was created with the PQSASA1 program.
3. The SAS dataset with summary records that was created with the PQSASA2 program.
4. A text file with Census area residential populations, stratified by area, sex, and discrete age categories. Three such files are currently provided along with the PQI module software. The files are QIPOPA97, QIPOPA98, and QIPOAP99. The user should select the file for the year that best matches the user's discharge datafile. The text file does not need to be converted to a SAS file for use with the software.
5. A text file (MEANSA97.TXT) containing overall means from the reference SID dataset for use in the risk adjustment process. This file is provided to you as part of the PQI module. The text file does not need to be converted to a SAS file for use with the software.
6. A text file (COVARA97.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 PQI module. The text file does not need to be converted to a SAS file for use with the software.
7. A text file (MSX97.TXT) containing three arrays for use in the smoothing process. The arrays contain noise estimates, signal estimates, and mean area rates for each PQI. This file is provided to you as part of the PQI 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 three types of indicator rates, along with the components of the initial raw rates. Specifically, the file contains the observed rates (OAPQxx variables), the risk-adjusted rates (RAPQxx variables), the smoothed rates (SAPQxx variables), the counts of outcomes that formed the numerators of the observed rates (TAPQxx variables), and the residential population totals that formed the denominators of the observed rates (PAPQxx 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 OAPQxx observed rates and their TAPQxx and PAPQxx components, the RAPQxx risk-adjusted rates, and the SAPQxx smoothed rates. Each record or row in the text file will correspond to a different area.
3. Output to hardcopy are PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of all of the numeric variables in two intermediate work files and in the final output data file. The printout also contains a PROC PRINT and PROC CONTENTS of the output SAS dataset.

### 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 IN3" and "LIBNAME OUT3" statements.

3. In CONTROL.SAS, specify in the "INFILEA3" statement the name of the discharge-level file that you created with the PQSASA1 program.
4. In CONTROL.SAS, specify the path (including the file name) for the ASCII population text file in the "FILENAME POPFILE3" statement. The file name will be QIPOPA97.TXT or QIPOPA98.TXT or QIPOPA99.TXT. These files are provided along with the software. The file used should be the one that is closest to the year associated with your particular data. These files contain Census residential estimates by area, gender, and discrete age categories.
5. In CONTROL.SAS, specify in the "FILENAME MEANSA" statement the path (including the file name) for the ASCII text file that contains overall means from the reference SID dataset. The name of the file is MEANSA97.TXT.
6. In CONTROL.SAS, specify in the "FILENAME COVARA" statement the path (including the file name) for the ASCII text file that contains regression coefficients from a regression that was run on reference SID dataset. The name of the file is COVARA97.TXT.
7. In CONTROL.SAS, specify in the "FILENAME MSX" statement the path (including the file name) for the ASCII text file that contains the estimates to smooth the indicator rates. The name of the file is MSX97.TXT.
8. In CONTROL.SAS, specify in the "INFILEA2" statement the name of the summary file that you created with the PQSASA2 program.
9. In CONTROL.SAS, specify in the "OUTFILA3" statement the name that you wish the output file to have.
10. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then set the TEXTA3 parameter to 1. Otherwise, the default value of zero for TEXTA3 will skip around the code that would generate this file.
11. 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 PQTEXTA3" statement.



## Reviewing the printed output.

This section contains tips for reviewing some of the printed output from the PQI 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 21.

### **PQSASA1**

The initial printout from the PQSASA1 program contains **PROC MEANS** for all of the numeric variables in the output discharge-level dataset. It will contain information for the newly constructed TAPQxx flag variables that will later form the numerators for the indicator rates. For each TAPQxx flag variable:

- The SUM will contain the total number of observations in the dataset that were found to have the particular outcome of interest.
- For the majority (14 of 16) of the indicators, the MEAN, MINIMUM, and MAXIMUM will usually be the value one since the flag variables have either been set to missing (‘.’) or to a value of one. The two exceptions to this are the two indicators (#2, for Perforated appendix, and #9, for Low birth weight) that will be based on subsets of the hospitalized population rather than the area residential population (see Table 1 on page 4). For these two indicators, a value of zero was assigned to the TAPQxx flag if a particular observation was part of the population for the rate denominator but did not have the particular outcome of interest to be included in the rate numerator. So for example, TAPQ02 = 0 implies a patient who had an appendectomy performed, but did not have a perforated appendix.
- For the two hospital-based indicators (#2 and #9), the MEANS will contain a close approximation of the eventual overall observed indicator rates. The values will change slightly after PQSASA2 has applied additional parts of the indicator definitions.
- N lists the number of observations in the dataset with non-missing values. For the 14 area-based indicators, N for TAPQxx will be the same as the SUM. For the two hospital-based indicators, N will contain the denominator for the observed indicator rate.

The PQSASA1 printout also contains a **PROC CONTENTS** that lists all of the variables in the output dataset, including the character variables that are present.

### **PQSASA2**

The printout from the PQSASA2 program contains **PROC MEANS** for all of the numeric variables in the output summary dataset. It will contain information for the newly constructed OAPQxx rates, the PAPQxx denominators, and the TAPQxx 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 TYPELEVL parameter values that were specified (see change #5 under the PQSASA2 program on page 16). So for example, if the default TYPELEVEL values of 0, 8, 9, 10, 12 were used, then the MINIMUM for `_TYPE_` is zero, the MAXIMUM = 12, and the MEAN and SUM have no particular meaning since the statistics reported span all records that were formed at different levels of aggregation.
- The N statistic for `_TYPE_` contains the number of records in the output summary data set. A TAPQxx 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 PAPQxx denominator variable with a lower value for N than `_TYPE_` indicates that for some stratification cells, the Census residential population estimate was zero.

- The MINIMUM value for the perforated appendix and the low birthweight TAPQxx 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 other 14 indicators, based on the residential area population, the MINIMUM value will be one or higher.
- If overall rates were requested (by including a value of zero among the TYPELEVL values), then the record that contains these overall rates will have the largest values for the TAPQxx and PAPQxx counters; i.e., the MAXIMUMs for these variables are for the overall dataset. So in this case, the TAPQxx maximums should equal the SUMs that were reported in the preceding PQSASA1 printout since they both contain totals for the overall discharge-level file.
- In general, the MEANS and SUMs in this printout have no intuitive meaning because numbers are added up repetitively over the stratifiers. However, if data was aggregated at only one level such as area (by having TYPELEVL include only the value of 8), then the SUMs will contain overall file totals for the counter variables TAPQxx and PAPQxx.

The subsequent **PROC PRINT** output contains a complete dump of the output summary file. Listed for each record are the stratification values, the PAPQxx population denominators for the 16 indicators, the TAPQxx outcome numerators for the 16 indicators, and the 16 OAPQxx observed rates.

### **PQSASA3**

The processing performed by this program is primarily at the area level. (Overall statistics for your dataset are also produced.) As a result, the PQSASA3 printed output is easier to interpret than the output from the preceding run when multiple stratifications may be in play.

There are three **PROC MEANS** given in the printout. The first two of these may be skipped over if you wish since the results are repeated in the third MEANS table. They are included primarily as a troubleshooting device. The first MEANS table is generated immediately after the risk-adjusted rates have been calculated. The second MEANS table is generated immediately after the smoothed rates have been calculated. The third MEANS table is on the permanent area-level output file.

- The N 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. Note that the MAXIMUMs for the counter variables (the TAPQxx and PAPQxx variables) are associated with specific areas, and therefore these MAXIMUMs may not match those in the prior PQSASA2 printouts since that run typically will include a record for the entire database.
- The SUMs of the counter variables (the TAPQxx and PAPQxx variables) yield the overall database totals. These overall database totals should agree with those reported in the previous programs; e.g. with the PQSASA2 MAXIMUMs if overall rates were requested.

At the end of the printout is a **PROC PRINT** on the final area-level output file. Listed for each indicator are the area, the numerator and denominator totals for the observed rates, and the observed, risk-adjusted, and smoothed rates.

## **Interpreting the results.**

After performing all of the steps as previously outlined, users will have three estimates of performance for each PQI – observed, risk-adjusted, and MSX smoothed. This section will outline how these estimates can be used.

The Prevention Quality Indicators are not intended as definitive quality measures. But they are useful, low-cost measures that can potentially illuminate differences between providers and areas that may be addressable using quality improvement techniques.

Since there are no “right rates” established for most indicators, it is often best to compare area-level rates with other similar areas. These “peer groups” would ideally be as similar as possible in potentially important factors, such as socioeconomic status of the population, and urban or rural location.

Performance on a single PQI often cannot reliably indicate actual quality differences. For this reason, some indicators have been developed as measure sets. For instance, diabetes has four different ACSC indicators. Examining these indicators together is likely to produce a more complete picture of overall quality of care for this condition.

### ***Observed means.***

Interpretation of the observed (raw) PQI 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 PQI 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.

### ***Risk-adjusted rates.***

Simply put, risk-adjusted rates are the estimated performance of areas on the PQIs if those areas had an ‘average’ casemix, as defined by age and sex. This average casemix is estimated and included in the software using estimates from 19 States in AHRQ’s State Inpatient Databases (SID). Estimates of the average casemix do not reflect only the areas in the dataset being analyzed, but rather the distribution in age and sex among the areas in the SID data.

All area indicators are risk-adjusted using age and sex, except for low-birth weight, which is not risk-adjusted. Ideally, one might like to adjust for the underlying health status of each area, but population-based measures of health status by demographic groups are not readily available.

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

The construction of risk-adjusted rates in the PQI module follows the method described in Greene, *Econometric Analysis* (2<sup>nd</sup> Ed), 1993, Section 16.4.2 on calculating fixed effects in a linear model. Two important features of this approach should be noted. First, the risk-adjusted rates are coefficients on area level covariates (‘fixed effects’) in a linear model for each PQI that also accounts for patient demographics (age and sex). Generally, these coefficients reflect the relative performance on the PQI relative to a reference or ‘omitted’ group (e.g., males age 65-69). As a result, the risk-adjusted rates for each area would reflect performance on the PQI for the reference group only, making interpretation and comparison with the observed raw rates problematic. Rather, the approach incorporated into running the model is to first subtract the overall PQI mean for each covariate (e.g., age category 1, age category 2, etc.) prior to running the model. The benefit of this approach is that the risk-adjusted rates (the ‘fixed effects’ in the model) now reflect the estimated performance on the PQI for each area if that area had the ‘average’ casemix among all areas in the estimation sample.

Second, because the model is linear, rather than logistic, 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 area has a more severe than average casemix. The model would predict that the area's performance with an 'average' casemix 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 area has a less-severe-than-average casemix. In order to facilitate the interpretation of the estimates, the PQI module imposes a lower bound of zero; i.e., negative values are set to zero.

### ***MSX smoothed rates.***

The PQSASA3 program also yields the estimated MSX smoothed rates for each PQI. These smoothed rates are estimated using multivariate signal extraction (MSX). MSX is a Bayesian smoothing technique. Generally, indicators defined on relatively small populations 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, 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 program accomplishes this by adjusting toward the overall area mean according to the degree of reliability of the specific provider or area indicator.

The MSX method estimates reliability by looking at area performance among multiple indicators and across multiple years for a single indicator. If areas that perform high in one year also tend to perform high in the next, and areas 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 an area's performance on a single indicator in a single year is "signal" and how much is "noise". PQSASA3 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 Prevention Quality Indicators are among measures and over time for a typical area are based on estimates using the 19 states in the SID database. Therefore, PQSASA3 does not require multiple providers, measures, and years of data to operate. Instead shrinkage estimates were calculated from the combination of 19 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 PQI if MSX could be applied to the dataset being analyzed. These shrinkage estimates are then applied to the adjusted rates for each PQI, giving 'smoothed' estimates of the rates.

The smoothed estimates represent the best guess of what the provider performance would be for any given PQI 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 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

The purpose of the analysis determines which rates the user should look at in evaluating the performance of an area. If the user's primary interest is to focus on a particular area without any comparisons to other areas, simply examine the overall observed rate for the entire area, as well as further breakdowns by age, sex, and race/ethnicity which are the output created by the PQSASA2 program. Trend data are recommended for identifying changes over years.

If the purpose of the analysis is to compare the performance of a particular area with national, state, or regional averages or performances of other selected areas, then both observed and risk-adjusted rates should be examined. Variation in observed rates across areas is attributable to a variety of factors including differences in population demographics, disparity in access to and quality of care or other area 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 area's population and the population of other areas. If the difference is minimal, one can compare the area's observed rate with the overall average across all areas. However, to account for differences in population demographics among different areas, risk-adjusted rates should be used for area-by-area comparisons.

After removing the impact of 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 areas 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 demographic composition of the area relative to the demographic composition of all areas combined*

Observed rate > Risk-adjusted rate	The area's population has a <b>higher</b> risk of being admitted to hospitals for the condition due to its demographic composition (for example, older or a greater proportion of a higher-risk gender).
Observed rate < Risk-adjusted rate	The area's population has a <b>lower</b> risk of being admitted to hospitals for the condition due to its demographic composition (for example, younger or a greater proportion of a lower-risk gender).
Observed rate = Risk-adjusted rate	The area's population is similar to other areas in demographic composition, suggesting that the demographic composition is not a contributing factor to the area's performance for the indicator.

#### Comparing Risk-adjusted Rates with Smoothed Rates (optional)

*Purpose: To determine if differences in risk-adjusted rates across areas are due to systematic or random factors after demographic composition is taken into account.*

Risk-adjusted rate <b>similar to</b> Smoothed rate	The area's risk-adjusted rate is more precise, an accurate reflection of the area's systematic ('true') rate. If there is any difference between the risk-adjusted rate and the overall area average <sup>1</sup> , such difference is likely to be due to systematic factors.
Risk-adjusted rate <b>different from</b> Smoothed rate	The area's risk-adjusted rate is less precise <sup>2</sup> ; that is, some of the difference between the risk-adjusted rate and the overall area 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 area average reveals more accurately the 'true' performance of the area.

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

## Benchmark timings

The benchmark runtimes given below are from runs made on a Windows NT 4.0 workstation, with a Pentium II 400 MHz processor, 256 MB of RAM, and a SCSI hard drive. The dataset used contained 763,363 observations with 15 diagnosis fields and 15 procedure fields.

<b>Step</b>	<b>Run time (in seconds)</b>
Run PQFMTS to create the format library	002
Run PQSASA1	367
Run PQSASA2	022
Run PQSASA3	244

## **User Support**

We would like to receive your feedback on the AHRQ Quality Indicators.

Our Internet address for user feedback is: [QI@ahrq.gov](mailto:QI@ahrq.gov)