

**Adult Cardiac Surgery National Database
of the
Society of Thoracic Surgeons
Software Specifications**

Version 2.52.1

**Changes Made to the STS Adult Cardiac Software Specifications
From v2.52 to v2.52.1**

After the release of v2.52 of the STS Adult Cardiac Software Specifications, with the development of the software certification auditor’s manual and after having all of the vendors looking through this document, a few items were identified that needed to be corrected or changed. These changes are itemized below. Although this document is now labeled with version number 2.52.1, the data records created using the new version of the specifications will still contain a Data Version value of 2.52.

Section	Item number	Change
Data Specifications	5.	In the first paragraph, the text “contains 19 fields” was corrected to “contains 20 fields”.
Data Specifications	5. E., first bullet	The text “and the field must be included in the data files exported for submission to the STS database” was removed since it is the Harvest field and not the Core field that makes that determination.
Data Specifications	just after 5. O.	Description for the “Parent Short Name” was added. The item letter for each subsequent field (P – S) was incremented by one letter (Q – T).
Software Specifications	2. C.	The second and third paragraphs were replaced to describe the method to be used to determine the data version number for a record.
Software Specifications	4.	The second sentence was removed since the 2.52 version of the specs contains fields with many more layers of parent/child relationships.
Software Specifications	4.a., 4.b. and 4.c	These three paragraphs were changed to include a description of how parent/child fields are handled if “No” values are being automatically inserted in the child fields by the software.
Appendix B		Algorithm was changed to include code for determining the procedure type based on the Data Version value.

Purpose:

The purpose of this document is to describe the features that are required to exist in software certified by The Society of Thoracic Surgeons (STS) for the collection and submission of adult cardiac surgery data. The STS is making an effort to set minimum standards for the software to be used by its members, while allowing enough flexibility so that developers can produce competitive features for the members' benefit.

The intended audience for this document is the software developers who are designing and maintaining the code used by participants to collect and submit data to the STS database. This information will be essential for developers working for vendors who will distribute their software to many members as well as developers working for an individual member designing a package to be used only by themselves (Participant Generated Software).

Since the functionality of the software will revolve around the data specifications, this document will start by providing some information about the specifications.

Data Specifications:

1. Purpose of the Data Specifications

The data specifications describe the data fields that are required to exist in certified software. It details the field names, definitions, dependencies, acceptable values, the harvest codes associated with those values, etc. Developers of certified software should use the data specifications to ensure their software:

- a. includes all core fields in the application (see description of core fields below)
- b. follows the defined field dependency rules (see description of Parent / Child relationships below)
- c. provides a defined default field value if appropriate
- d. accepts only the defined valid values appropriate to each field and ensures that the values are in the correct format
- e. provides the user with appropriate warnings or error messages for unusual or missing values

2. Data Version Numbers

As medicine, technology and interest in research areas change, the data specifications have and will change to collect additional and more detailed

information. A Data Version number is assigned by the STS to each official version of the data specifications. This number will play a key role in how the data is handled and processed (see Software Specifications below).

STS members were required to start using certified software as of January 1, 2000. At that time, version 2.35 of the data specifications was put into affect and any data collected for procedures performed before January 1, 2000 were converted to the 2.35 format as closely as possible.

Since that time, the data specifications have been upgraded twice; first to version 2.41 and now to version 2.52. At the time of each upgrade, there is a six month conversion period when the data can be recorded following either the version being replaced or the newer version. The following table defines which version of the data specifications will be accepted into the national database for procedures performed during the specified time periods (note: more than one version number will be accepted in two time periods to allow for sites still entering their data into an old version of the software while waiting to have their software upgraded.):

Surgery date	Data Specifications version number
Any dates up to December 31, 1999	Data converted to 2.35 format
January 1, 2000 through December 31, 2001	2.35
January 1, 2002 through June 30, 2002	2.35 or 2.41
July 1, 2002 through December 31, 2003	2.41
January 1, 2004 through June 30, 2004	2.41 or 2.52
Any date on or after July 1, 2004	2.52

3. Sequence Number

The sequence number field (SeqNo) is provided in the data specifications solely for identifying fields and sorting fields within the data specification database. They are not intended as a permanent identifier for individual fields and a number assigned to a field in one version of the data specifications might be assigned to a different field in another version. Because of this, it is highly recommended that developers should not use the SeqNo value as a field identifier in any of their programs. See Appendix C for a list of SeqNo values for each field for each of the most recent versions of the data specifications.

4. Future Upgrades

As the need arises, new versions of the data specifications will be distributed by the STS. In the interest of keeping major software upgrades and testing down to a minimum, the STS does not expect to upgrade the specifications more frequently than once every other year. Developers should anticipate these upgrades and design their software in such a way that the new versions can be incorporated with minimal software changes and that records created under different data versions will be handled properly, as described below.

5. Data Specifications field descriptions

The data specifications are maintained in a table in an Access database to allow the information to be cut and pasted, sorted and reported on in a variety of ways to make incorporating the information easier. The table for the 2.52 version of the specifications contains 20 fields which are described here:

- A. Section – The section of the Data Collection Form (DCF) in which the field is located.
- B. SeqNo – An arbitrary number (sequence number) used for ordering the fields within a specific version of the data specifications. The ordering of the numbers is set to loosely follow the order in which the fields appear in the DCF. As described above, the SeqNo value for one field can change from one version of the specifications to the next. The values, therefore, should never be used in any reports, queries or programs to refer to a specific field.
- C. FieldName – The longer and more descriptive name of the field. In most cases, the FieldName does not change from one version of the specifications to the next, but they do change in some instances. Because of this, the FieldName value should never be used to refer to a field in reports, queries or programs.
- D. ShortName – The short (8-characters or less) programmatic name assigned to the field. The ShortName value should be used in all reports, queries and programs to refer to a given field as this value will not change from one version of the specifications to another.
- E. Core – This field contains a value of Yes or No to define whether or not the field should be available to the users for data entry. These values have the following meanings:
 - Yes = Field must be available to the users for entering data for records following this version of the data specifications and the field must be included in the data files exported for submission to the STS database.
 - No = Field is not required to be available to the users for entering data for records following this version of the data

specifications. Whether or not the field is included in data files exported for submission to the STS database depends on what other data versions are being included in the data extract. (See the “Data export for harvest to the data warehouse” section of the Software Specifications below.)

- F. Harvest – This field contains a value of Yes, No or Optional to define whether or not the data for this field is included in the export file to be submitted to the data warehouse. (See the “Data export for harvest to the data warehouse” section of the Software Specifications below for more details about the contents of the files submitted to the data warehouse.) The values for this field have the following meanings:
- Yes – Data from this field must be included in the data file for all records following this version of the data specifications.
 - No – Data from this field must not be included in the data file for all records following this version of the data specifications.
 - Optional – The individual users determine whether or not the data from this field is included in the data file. By default, the software should treat this as a Yes and include the data in the extract. The users must explicitly state that they do not want the data for this field included.
- G. Status – This field defines what has happened to the field moving from the previous version of the data specifications to this version. This field will have one of the following values:
- New – This field was not a core field in the previous version but now is a core field in this version.
 - Extended – This field was a core field in the previous version but now is not a core field in this version.
 - Changed – This field is a core field in both the previous and current versions. However, something has changed for this field between the two versions, the details of which are itemized in the field ChangesFrom241To25x.
 - Continued – This field is a core field in both the previous and current versions and nothing has changed for this field between the two versions. Note that in the 2.52 version of the specifications, no fields have a status of Continued.
- H. Format – The format in which the values for the field should be collected.
- I. DataSource – This field defines how the data is entered into the field. The options for this field are:
- User – The user enters the value, otherwise it is left missing (null).

- Automatic – The software automatically inserts a value for every record. This is usually assigned to administrative fields that must contain a value, such as the DataVrsn field.
 - Calculated – The value is calculated by the software based on values in other fields (for example, the risk model fields).
 - Lookup – The software automatically inserts a value after looking up the information kept in a table maintained by the user (for example, HospStat is filled in based on which HospName value is selected).
- J. Default – The default value in a field if no other value is entered. This field can have the following values:
- (null/blank = missing) – Most fields are left missing if no value is explicitly entered. A null is used to specify missing.
 - (assigned value) – A specific value that is constant across most records is entered onto every record (such as VendorID).
 - (unique value) – A specific value that is determined by the software that is unique to each record is entered by the software (such as RecordID).
- K. Definition – The official definition of the field.
- L. ValidData – The values that can be accepted for the specified field. This can be a list of values or a numeric range. (See the “Data Entry” section of the “Software Specifications” portion of this document).
- M. UsualRange – The range of values that are expected to be entered in most cases. (See the “Data Entry” section of the “Software Specifications” portion of this document).
- N. HarvestCoding – The numerical code that is assigned to each choice in the valid data. These are the values that are used in the exported data file that is submitted to the data warehouse.
- O. ParentField – The “parent” field on which this field (the “child” field) is dependant. The parent field must contain a value that is specified in the ParentValue field before data can be entered into this field.
- P. ParentShortName – The STS short name of the parent field.
- Q. ParentValue – The list of values the parent field can have before this field can be available for data entry.
- R. MissingData – This describes what action should be taken by the software when quality control procedures are run on the data and a value in this field is missing. See the “Data quality and completeness checks” section of the Software Specifications below.

- S. ACCField – This field indicates whether or not the 2.52 definition for this field maps to a similar field in the 3.0 version of the American College of Cardiology (ACC) data specifications. This field will contain one of the following values with these meanings:
- “Not mapped” – There is no ACC field that is similar to this STS field in definition or coding.
 - “Mapped – Definition only” – There is an ACC field that is similar to this STS field in definition, but not in coding. These two fields will have some difference (such as the time at which the value is collected) that precludes the data from being combined or stored in the database as one field.
 - “Mapped – Definition and coding” – There is an ACC field that is similar to this STS field in definition and coding. These two fields can be combined and stored in the database as one field.
- T. ChangesFrom241To25x – The itemized list of changes made to the field specifications between data specification versions 2.41 and 2.52.

6. Global changes between versions 2.41 and 2.52

Two changes between versions 2.41 and 2.52 affect almost all of the fields. They are changes to the sequence numbers and section titles. As these changes are more global in nature, they are not itemized in the “ChangesFrom241To25x” field.

The sequence numbers (SeqNo) for almost every field were changed to reflect the changes in the field locations on the data collection form and to make room for the many new fields. Appendix C can be used to see the different SeqNo values for each field in the different data versions.

The section titles were changed to reflect the movement of entire sections on the data collection form as well as to make room for the new sections. The table below describes the changes in section names between the two versions:

2.41 Section Name	2.52 Section Name
A. Administrative	A. Administrative
B. Demographics	B. Demographics
C. Hospitalization	C. Hospitalization
D. Risk Factors	D. Risk Factors
E. Previous Interventions	E. Previous CV Interventions
F. Cardiac Status	F. Preoperative Cardiac Status
G. Medications	G. Preoperative Medications
H. Hemodynamics & Cath	H. Hemodynamics & Cath

I. Diagnosis	(section no longer exists)
J. Operative	I. Operative
K. Coronary Bypass	J. Coronary Bypass
L. Valve Surgery	K. Valve Surgery
	L. VAD (new section)
N. Other Cardiac	M. Other Cardiac Procedures
O. Other Non Cardiac	N. Other Non Cardiac Procedures
P. CPB and Support	(section no longer exists)
Q. PostOperative	O. Postoperative
R. Complications	P. Complications
T. Mortality	Q. Mortality
S. Discharge	R. Discharge
U. Readmission	S. Readmission
V. Risk Scores	T. Risk Scores
M. Operative Techniques	X. Operative Techniques (Only extended fields remain in this section)

Software specifications:

It is not the intention of the STS to regulate the algorithms and methodologies the developers use to produce their software. However, there are specific features and functionalities that are needed in the software to allow data to be collected and submitted in a uniform format and to enable the warehouse to communicate with the members about individual records and data items. The purpose of this section is to describe those features and functions.

1. General features

The certified software must have the following minimum features:

- a. A user-friendly interface that can be used on a current personal computer operating system.
- b. Allow users to be able to view and select the actual data values for each field. If the data is coded internally, user should, by default, view the non-coded values.
- c. Ensure all date values are year 2000 compliant having a 4-digit year format.
- d. The STS database has a logical flat structure in which each record describes one surgical case. If a developer chooses, this can be implemented as a set of relational tables (e.g. demographics table, procedure table, etc.), but the software must be able to export the data in a flat file structure compatible with that of the STS. (See “Data Export for Harvest to the Data Warehouse”, below).
- e. Software must accept and integrate STS data previously collected and maintained in other software products or data versions. (See “Data Import”, below).
- f. The user’s data must be accessible for *ad hoc* queries either through the software package or by common third party software (e.g. Microsoft Access Crystal Reports, etc.) If the data is not directly accessible, then the software must provide the ability for the user to export the data in a standard file format which can be queried using common third party query software. (See “Data Export for Analysis by Users”, below). When users are querying their data, grouping records that were created under multiple data version numbers must be invisible to the user. For example, if a user wants to analyze a risk factor in their data for a time period of two years, the fact that their data was recorded under two different version numbers during that period must not require any additional steps for the user to build the query. We strongly recommend ensuring this by keeping all data in one database regardless of the version number. This requirement is the result of feedback from many frustrated users.

- g. Users must be able to select specific records in their database via key fields including patient's name, medical record number, and the record identification field (RecordID).

2. Record management

Each record in the database describes one surgical case. On each record, there are four key fields used for record management:

- a. Participant identification number (ParticID): Each group of surgeons collecting and entering data into a database for submission to the STS is assigned a 5-digit ParticID by the STS. In most cases, all data being entered into a database will be for one participating group, in which case all records will have the same value in this field. In these situations, the developer can have the software enter the value into the record automatically for the user.

In some situations however, more than one participating group will be entering their data into a single database. In these situations, the user should select the appropriate ParticID value from a drop down list (see "Categorical values specified by user" under the Data Source description in the "Explanation of Data Specification Terms", below).

The developer should consult with the users to determine how many participants will be entering data into a single database and adjust the programs accordingly. In either case, a value for ParticID is required and the software should ensure one exists for every record.

- b. Record identification number (RecordID): The RecordID field contains a unique numeric value that identifies the record in the database. This is an arbitrary number and must not be a value that could identify the patient, such as Social Security Number, Medical Record Number, etc. Once attached to a specific record, the value can never be changed, nor can it be reused if the record is deleted. The data warehouse uses the RecordID field to communicate record-specific data quality issues to the participants. Because of this, users must be able to select cases from their database for review using this field and the field must be labeled "RecordID" on the data entry screen. See also the special considerations necessary for this field when importing data from another database in the "Data Import" section, below.

Together, the ParticID and the RecordID will affect a composite

key, which is unique to each record throughout the national STS database.

- c. **Data Version Number (DataVrsn):** The DataVrsn field contains the data specifications version number under which the record is created. The value is automatically entered into the record by the software at the time the record is created. The value then can never be changed, even if the software is upgraded to a newer version of the specifications.

Starting with the software upgrade to handle 2.52 data records, the data version value that is assigned to a record is determined by the surgery date of the procedure in the following manner:

- A) The date of surgery should be asked of the user either before or immediately after a new record is created. In other words, if it is not asked before the record is created, it should be one of the first questions after the record is created. This will avoid having the user enter a lot of data before realizing they are using the wrong set of rules and having to reenter all of that data. For point-of-care data entry, where the surgery date has not been determined, the current system date can be used or an anticipated surgery date.
- B) If the surgery date is prior to January 1, 2004, the data record must be in version 2.41. If the record was already created under a different version number, when the surgery date is entered or changed, an error message must tell the user a different record should be created for that patient. Similarly, if the surgery date is on or after July 1, 2004, the data record must be in version 2.52 format or the user gets a similar error message.
- C) If the surgery date is between January 1, 2004 and June 30, 2004, then the version number depends on the relation between the surgery date and a "change over" date in the following way:
 - (i) The preferred (default) change over date is January 1, 2004.
 - (ii) Users can define a different change over date for their system as long as it is within the first six months of 2004. (In future versions of the specifications, the users may not have this option and the change over date will be specified by the STS, such as January 1st).
 - (iii) If the surgery date is before the change over date, the record should be version 2.41. If the surgery date is on or after the change over date, the record should be

version 2.52. Otherwise, the user should receive an error message.

- D) A data record can be viewed using the rules for any data version number, but changes to the data values can only be made when the rules for the correctly assigned version number are being used.

This new methodology will allow sites to enter records for procedures performed in 2003 using the 2.41 format even after they have their software upgraded to be able to handle version 2.52 records.

Once a record is created and a data version has been assigned to it, that record will always follow the rules defined by that version of the data specifications. When a user selects a record for editing that has an older data version number, the software must follow the older data specification rules for editing that record. This includes controlling which fields are available to the user, which values are available for each field and the appropriate parent/child dependencies.

- d. Patient identification number (PatID): The PatID field contains a unique, arbitrary number to uniquely identify the patient in the database. If one patient has multiple admissions to the hospital, the records for each admission will contain the same PatID value. The number, once assigned to a patient, can not be edited or reused if the patient records are ever deleted. In order to avoid issues of patient confidentiality in transferring records, the PatID value should not be any known identifier such as Social Security Number or Medical Record Number. Starting with version 2.52 of the data specifications, a PatID value is required on every record regardless of the structure of the software's database.

3. Data entry

The software must have the following features to control the data being entered by the users:

- a. For export of data to the warehouse, most data fields have a default value, usually null or blank, which indicates that the data is "Missing" (see data specifications). For data entry purposes the site and vendor may choose to institute internal codes for "Missing" values. As the site drives the need for this feature, the STS data specifications do not define standard codes for "Missing" values

during data entry. If a site applies data entry "Missing" codes, the harvest process must include a step that maps the missing code to the STS specification for "Missing" values (null or blank). Note: zero must never be used to indicate missing data.

- b. The user should always be able to delete entered data, and return the field's value to the null or blank "Missing" value.
- c. For any field having "Valid Data" specified, the software must restrict data entries to this set of values. For categorical variables this is expressed as a set of valid text values and the user must select from a pick list of these values. For numerical variables, this is expressed as a valid numeric range and the user must enter a value on or between the specified lower and upper limits.
- d. Where a numeric variable has a "Usual Range" specified, if the user attempts to enter a value that is outside of that range but still inside the Valid Data range, the software must warn the user that they are entering an unusual value and ask if the entry is correct. If the user confirms that the value is correct, then it should be accepted into the field.
- e. Some categorical text fields are designed to have data values controlled by the user. This applies primarily to a few site-specific fields such as hospital name and surgeon name. These fields are indicated in the Data Specifications by their Format specifying "categorical values specified by user", and their Valid Data specifying "(elements of user list)". The user should be able to maintain the pick list of valid data for these fields including the ability to add, change, or delete list elements. During data entry, the user should be able to enter only values that are in this pick list.

The process of maintaining the list should be separate from the data entry process. In other words, users must purposely add a value to the list to make it available for selection during data entry. If a user enters a value that is not on the list, it should be rejected and not automatically added to the list. The idea here is to avoid the possibility of users entering "free text" which causes unacceptable data quality issues at the warehouse.

It is important that the vendor support the site's ability to control these fields. Items in the user list should not have more than one choice for the same entity. For example, the hospital names "General Memorial Hospital" and "GMH" should not represent select choices for the same hospital.

- f. Documentation including data definitions and help should be easily accessible to the user, preferably on-line.
- g. Specific considerations are needed for the fields related to valve prostheses. There is an implicit relationship within the data describing valve prostheses. Specifically, there are constraints between the prosthesis type and the prosthesis name.

This applies to four different potential prostheses per operative case record: one at each of four valve positions (Aortic, Mitral, Tricuspid, and Pulmonic).

Software should be written so that once a prosthesis type is chosen, only the prostheses of that chosen type are allowable potential data entries for the prosthesis name. See Appendix A for a list of the data fields containing the prosthesis type and the corresponding prosthesis name.

For any prosthesis type, the prosthesis name choices of "Other" should always be available.

4. Field dependencies

Field dependencies exist where one field ("parent" fields) controls whether or not one or more other fields ("child" fields) can contain data. Child fields are indicated in the specifications by having their immediate parent field named in the "Parent Field" section of their specification. For example, "Angina" is a parent field to its child "Angina Type". The following guidelines must be followed to handle dependent fields:

- a. If the data value of a parent field indicates that no data should be in its dependent fields, then those dependent fields should be skipped or unavailable on the data entry screen. In the example above, only if Angina = "Yes" should Angina Type be available for data entry.
- b. If a parent field contains a "No" value, vendors can choose one of two methods for handling the values in the associated child fields:
 - 1. set all child field values to Null, or
 - 2. set child field values to "No" as is appropriate.

Note that the STS highly recommends following the first method of setting all child fields to Null.

Vendors must keep in mind that the first method is required in the export file created for submission to the data warehouse. In other words, regardless of what is in the user's database, the export file must contain Nulls in child fields when the parent is No.

Also, vendors must notify the STS and the data warehouse if their software will insert No values into child fields when the parent is No. This will allow the warehouse to know that the data received by a site during a data harvest will not look exactly like what the user has in their database.

- c. If a parent field is originally set to "Yes", then values can be entered into its child fields. If the record is subsequently edited by the user and the parent value is changed to "No", the values in the child fields must be automatically changed to Null or No depending on the method being used by the vendor as described above. This will avoid the possibility of conflicting information being left in the data record (for example Angina is "No" but an Angina Type is specified).
- d. Reporting on missing data values needs to be handled differently in dependent (child) fields, since its meaning depends upon the data value of the parent field. See "Data quality and completeness checks" below for a full description of how this should be handled.

5. Data quality and completeness checks

The software must provide the users with a utility for checking the accuracy and completeness of their data that includes the following features:

- a. Data quality checks can be run during data entry and/or on demand for groups of records as specified by the user. This utility produces a data quality report indicating which records and fields failed the data checks. This report is used by the site data manager to review and potentially repair the data.
- b. The data quality check utility sets the value of the "Record Complete" field to "Yes" if there are no missing data, or to "No" if there are missing data in that record. The value in this field does not control the ability to harvest an observation and is intended only as a data quality tool for the data manager at the site. Use of site-defined "Missing" codes will increase the usability of this data quality tool.

- c. The action taken for each field when data are found to be missing is determined by the value in its “MissingData” section in the Data Specifications as follows:
- i) **No Action** – Fields with this specification are expected to sometimes contain no data and therefore no action or reporting is necessary.
 - ii) **Illegal** – These are administrative fields and should never be missing. Software should ensure there is a value in each of these fields before the record is saved.
 - iii) **Report** – Field name and record identifier should be included in the data quality report to allow the data manager to review and repair the data values.
 - iv) **Report & Warn** – Field name and record identifier should be included in the data quality report and also produce a warning to the user that missing data in that field can affect how or if the record is used in the national analysis report.

Special consideration is needed for checking dependent fields for completeness. For these fields, the “Missing Data” section will indicate “Report” or “Report & Warn” along with an appropriate condition. The software should check to see if the condition is true before performing the specified action. For example, the Missing Data section for the Other Card-ASD (OCarASD) field contains “Report if parent is yes and child is missing”. For this field, if the value is missing and the value in the parent field Other Card (OpOCard) is “Yes”, then the “Report” procedure as described above should be followed. However, if OCarASD is missing and OpOCard is either missing or contains the value “No”, then no action should be taken for this field. Following this guideline will restrict the actions taken for missing data to only those fields where data is clinically expected.

6. Data Import

- a. Software must be able to import data in standard file formats from third party applications. At a minimum, this must include delimited, ASCII text files. Other common formats (e.g. Excel or MS Access) are also recommended.
- b. Data that is imported will require controlled conversion to an acceptable STS data version. The conversion process must include reviewing the data for consistency with the STS data (i.e. mapping the categorical values in the imported data to the

appropriate STS values). The site data manager and software vendor hold responsibility for the accuracy (both clinical definition and harvest format) of all imported data harvested to the warehouse. The software will assign to each imported record the STS data version number to which the data is converted. The warehouse will handle data according to the STS data version number on each observation in a harvest file regardless of whether it was created in the software's data entry utility or imported from another source.

- c. Special consideration is needed for the values in the RecordID field when importing data. This is especially true when importing data that was previously submitted to the data warehouse (i.e. data from another certified software package). RecordID values must never change once they are assigned to a record. The software developers and data managers must ensure that the values in the imported data do not change in the conversion process, and that they do not cause duplication of values with any existing records. Developers must also ensure that new records created after the data has been imported are not assigned RecordID values that already exist in the data. If data is to be imported that would cause a conflict in this manner, the software developer must contact the data warehouse to determine what steps need to be taken.

7. Record subsets and queries

- a. Software must allow users to search for Individual records selected by RecordID or by patient identifiers including patient name, SSN, medical record #, and surgery date. This is to benefit on site data quality actions and usability of the database.
- b. Software should allow groups of records to be selected (e.g. filter function) by multiple fields, which minimally include procedure type, surgeon, hospital, date of surgery, date of admission, and date of discharge.
- c. Users should be able to name, save, copy and modify record selection criteria.
- d. Users should also be able to construct more general queries including field selection, record selection, sorting, and summarizing. It is acceptable if this function is provided by a third party application (e.g. MS Access or Crystal Reports).

8. Reporting

Software should provide the users with reporting abilities that can do the following:

- a. View and print listing of records (either all records or a selected subset) with basic information such as, but not limited to, record number, patient name, SSN, procedure type, medical record number, date of birth, date of surgery, surgeon, and hospital.
- b. Print full record detail on single or multiple selected records.
- c. View and print a data completeness report listing the records having missing fields, which fields are missing from each record, and warnings if any missing data affects how or if a record is included in the national analysis. (See “Data quality and completeness checks”, above).
- d. Build, save, copy, and modify more general reports with capability to select fields, record subsets, sorting, and summary statistics. (It is acceptable if this function is provided by a third party application, such as MS Access or Crystal Reports).
- e. Incorporate capabilities for graphing the data in reports, including trends over time (it is acceptable if this function is provided by a third party application).
- f. Data harvest procedure provides the site with a report documenting the following:
 1. whether or not the extract completed successfully
 2. number of records extracted
 3. time frame of the data extract (by date of surgery)
 4. date the data extraction was performed
 5. name of the person who performed the data extraction

9. Data export for analysis by users

The software must allow users to export their data for their own use in the following manner:

- a. Software must be able to export data in standard file formats suitable for transfer into third party applications. This must include at a minimum delimited, ASCII text, and optionally other common formats such as Excel and Access. Developers should keep in

mind that sites may need to export their data for reasons other than the STS data harvests.

- b. User should be able to choose whether an export includes all data or selected records and fields.
- c. If data is coded for internal storage (e.g. text string is stored as a number), the data must be decoded when written to the export file so that actual values (e.g. full text strings) are contained in export file.
- d. Export files must have short field names in the first header row in the same order as the data in subsequent rows.
- e. User can build, save, copy, and modify named export configurations.
- f. User can control export file naming convention.

10. Data export for harvest to the data warehouse

As one of the key reasons for having certified software, the software must allow users to export their data for submission to the STS data warehouse following these exact guidelines:

- a. The user must be able to specify the records to be exported for harvest by using range limits for the surgery date.
- b. The Data Harvest file exported must adhere to this specific format:
 - 1. File is an ASCII text file with vertical bar delimiters
 - 2. The first row is a "header" record containing the STS short field names in the same sequence as the data fields in subsequent rows
 - 3. Each subsequent row represents one data record describing one surgical case
- c. Only a single harvest file for each participant can be submitted to the warehouse for processing. Participants may submit repeatedly during a harvest, but each submission is only one file.
- d. The extracted file must contain data for only one participant ID (ParticID) value. If the site's database contains data for more than one participant, all of which is to be submitted to the warehouse, the software must extract the data for each ParticID into separate data files each with an appropriate file name (see below).

- e. The harvest file must include all fields, and only those fields, defined in the data specifications with Core = "Yes" and Harvest = "Yes" or "Optional" for all STS data versions within the harvest file. In other words, a file containing 2.41 and 2.52 records would contain all fields where Core is "Yes" and Harvest is "Yes" or "Optional" for either version of the specifications (more information on submitting data from multiple data versions is given below). Fields with Core="No" or Harvest="No" and site-specific or custom fields must not be included in the export file.
- f. Fields that are defined as Core = Yes and Harvest = Optional must be included in the data file. What is "optional" is whether or not the field contains data. By default, the software should include all data for optional fields. If the user specifies that an optional field should not be included, the data file will include the field but every record will contain a blank (null) in that field. This is necessary for the warehouse to be able to tell the difference between a field being left out by mistake and a site opting not to include that data.
- g. The values in the harvest file must be the numerical "Harvest Coding" of the data values and not the full text strings.
- h. A harvest report should be produced whenever a data harvest is performed (see "Reporting", above).
- i. Certain fields not currently specified for harvesting, such as Patient Name, may need to be harvested in the future. Developers should provide the capability to "turn on" harvesting for non-harvested fields given future notification from the STS.
- j. Starting with version 2.52 of the data specifications, the software must create the exported data file using the file naming convention of XXXXXadt.dat where "XXXXX" is the 5-digit ParticID for the data contained in the file. The users should not specify the file naming convention. Files not using this naming convention can not be accepted by the automated process at the data warehouse and may be returned to the participant.

When records from more than one data version are being exported for an STS data harvest, the file must adhere to the following format:

- k. All data records for a single participant must be exported into one and only one data file.

- l. The first record of the file must be the one and only "header" record containing the STS short field names in the same sequence as the data fields in subsequent rows.
- m. Every data record in the file must contain the same fields which will consist of a superset of the Core, Harvested fields from all included data versions.
- n. On each data record, the fields that are Core and Harvested for the data version specified in the DataVrsn field will contain data values as available and appropriate. The fields that are not Core or not Harvested for that data version will contain nulls (blanks). When the data is being processed by the warehouse, only the fields appropriate for the data version specified on the record will be included.

For an example of a data file containing more than one data version, consider a data file being submitted with records having data versions 2.41 and 2.52. The software will produce one data file with one header record that will identify all of the Core / Harvested fields for both versions, including "Age", "Same Day Elective Admit" (SameDay), and "CPB Utilization" (CPBUtil). The Age field is Core to both 2.41 and 2.52. SameDay is Core for 2.41 but was not Core moving to 2.52. CPBUtil didn't exist in 2.41 but is a new, Core field in 2.52. A data record in the extracted file that has a DataVrsn value of 2.41 should contain a value in Age and SameDay, but would contain a null in CPBUtil. A data record that has a DataVrsn value of 2.52 should contain a value in Age and CPBUtil, but would contain a null in SameDay.

11. Customization

It is up to the developer's discretion as to whether or not the users will have the ability to add customized fields to their software and database. If the user will have this ability, the following items must be considered:

- a. In no case can the field names, short field names, or categorical data values specified by the STS be customized or modified by the users. (Please note however in the STS specifications that users can build the categorical data values for certain fields such as Hospital Name, see section "f" of "Data entry", above.)
- b. Fields added by users must not be included in the data file exported for submission to the STS data warehouse.

- c. Developers should make clear to the potential users whether users can add custom fields themselves, or if they will require contracted work by the developer.
- d. It should be possible for users of customizable software to import custom fields that they might have created in a previous database or software package.
- e. Most importantly, developers who allow users to add customized fields must keep in mind that software upgrades will be necessary from time to time as new versions of the data specifications become available. These changes include adding new fields, discontinuing fields, and moving fields to a new location. It is the developer's responsibility to handle how a user's customization is incorporated when their software is being upgraded.

12. Combining collection of STS and non-STs database fields

Developers who design their software to collect data for more than just the STS Adult Cardiac database must not combine fields from other databases with the STS fields unless it is explicitly stated in the STS data specifications that the fields are the same in definition and coding. At the time this document was produced, the only other database that has been designated as having fields in common with the STS Adult Cardiac database is the 3.0 version of the American College of Cardiology (ACC) database. Within the STS data specifications, the field called "ACCField" contains the information that defines which ACC fields can be combined with the STS fields (see section "5. Data Specifications field descriptions" in the "Data Specifications" section above).

Appendix A: Valve prosthesis and types

The valid data choices for the valve prosthesis fields are not meant to be an all-inclusive list. The included choices are the devices that are most commonly used and/or have the most interest for being identified in analysis.

Between versions 2.41 and 2.52 of the data specifications, too many changes were made to the values for these fields to itemize them in the Data Specifications document. Instead, the table on the next three pages was developed to describe how the values changed.

This table can also be used to determine the constraints between the prosthesis type and the prosthesis name (see the Data Entry section above).

STS Adult CV Data Specifications
Valve Prosthesis Changes in V2.52
 Comparison of versions 2.41 and 2.52

Items marked in **yellow** indicate values that are new to 2.52.

Items marked in **blue** indicate values that were valid in 2.41 but are not valid in 2.52.

2.52 key	2.52 status	2.41 key	2.41 harvest code	2.52 harvest code	Type	Prosthesis
M1	Continued	M1	2	2	Mechanical	ATS Mechanical Prosthesis
M2	Continued	M2	3	3	Mechanical	Björk-Shiley Convex-Concave Mechanical Prosthesis
M3	Continued	M3	4	4	Mechanical	Björk-Shiley Monostrut Mechanical Prosthesis
M4	Continued	M4	6	6	Mechanical	CarboMedics Mechanical Prosthesis
M16	New			57	Mechanical	CarboMedics Carbo-Seal Ascending Aortic Valved Conduit Prosthesis
M17	New			58	Mechanical	CarboMedics Carbo-Seal Valsalva Ascending Aortic Valved Conduit Prosthesis
M18	New			59	Mechanical	CarboMedics Reduced Cuff Aortic Valve
M19	New			60	Mechanical	CarboMedics Standard Aortic Valve
M20	New			61	Mechanical	CarboMedics Top-Hat Supra-annular Aortic Valve
M21	New			62	Mechanical	CarboMedics OptiForm Mitral Valve
M22	New			63	Mechanical	CarboMedics Standard Mitral Valve
M23	New			64	Mechanical	CarboMedics Orbis Universal Valve
M24	New			65	Mechanical	CarboMedics Small Adult Aortic and Mitral Valves
M5	Continued	M5	7	7	Mechanical	Edwards Tekna Mechanical Prosthesis
M6	Continued	M6	53	53	Mechanical	Lillehei-Kaster Mechanical Prosthesis
M10	Continued	M10	10	10	Mechanical	MCRI On-X Mechanical Prosthesis
M7	Continued	M7	8	8	Mechanical	Medtronic-Hall/Hall Easy-Fit Mechanical Prosthesis
M25	New			66	Mechanical	Medtronic ADVANTAGE Mechanical Prosthesis
M8	Continued	M8	9	9	Mechanical	OmniCarbon Mechanical Prosthesis
M9	Continued	M9	54	54	Mechanical	OmniScience Mechanical Prosthesis
M11	Continued	M11	11	11	Mechanical	Sorin Bicarbon (Baxter Mira) Mechanical Prosthesis
M12	Continued	M12	12	12	Mechanical	Sorin Monoleaflet Allcarbon Mechanical Prosthesis
M13	Continued	M13	13	13	Mechanical	St. Jude Medical Mechanical Prosthesis or St. Jude Medical Mechanical Heart Valve
M26	New			67	Mechanical	SJM Masters Series Mechanical Heart Valve
M27	New			68	Mechanical	SJM Masters Series Aortic Valve Graft Prosthesis
M28	New			69	Mechanical	St. Jude Medical Mechanical Heart Valve Hemodynamic Plus (HP) Series
M29	New			70	Mechanical	SJM Masters Series Hemodynamic Plus Valve with FlexCuff Sewing Ring
M30	New			71	Mechanical	SJM Regent Valve
M14	Continued	M14	14	14	Mechanical	Starr-Edwards Caged-Ball Prosthesis
M15	Continued	M15	15	15	Mechanical	Ultracor Mechanical Prosthesis
	Not Valid	B1	17		Bioprosthesis	Baxter Prima Plus Stentless Porcine Bioprosthesis
	Not Valid	B2	18		Bioprosthesis	Baxter Prima Stentless Porcine Bioprosthesis
B24	New			72	Bioprosthesis	Baxter Prima Stentless Porcine Bioprosthesis - Subcoronary
B25	New			73	Bioprosthesis	Baxter Prima Stentless Porcine Bioprosthesis - Root

B3	Continued	B3	19	19	Bioprosthesis	Biocor Porcine Bioprosthesis
	Not Valid	B4	20		Bioprosthesis	Biocor Stentless Porcine Bioprosthesis
B26	New			74	Bioprosthesis	Biocor Stentless Porcine Bioprosthesis - Subcoronary
B27	New			75	Bioprosthesis	Biocor Stentless Porcine Bioprosthesis - Root
B5	Continued	B5	21	21	Bioprosthesis	CarboMedics PhotoFix Pericardial Bioprosthesis
B28	New			76	Bioprosthesis	Carpentier-Edwards Duraflex Porcine Bioprosthesis
B29	New			77	Bioprosthesis	Carpentier-Edwards Prima Plus Stentless Porcine Bioprosthesis - Subcoronary
B30	New			78	Bioprosthesis	Carpentier-Edwards Prima Plus Stentless Porcine Bioprosthesis - Root
B6	Continued	B6	22	22	Bioprosthesis	Carpentier-Edwards PERIMOUNT Pericardial Bioprosthesis
B7	Continued	B7	23	23	Bioprosthesis	Carpentier-Edwards Standard Porcine Bioprosthesis
B8	Continued	B8	25	25	Bioprosthesis	Carpentier-Edwards Supra-Annular Aortic Porcine Bioprosthesis
	Not Valid	B9	27		Bioprosthesis	Cryolive O'Brien Stentless Porcine Bioprosthesis
B31	New			79	Bioprosthesis	Cryolife O'Brien Stentless Porcine Bioprosthesis - Subcoronary
B32	New			80	Bioprosthesis	Cryolife O'Brien Stentless Porcine Bioprosthesis - Root
B10	Continued	B10	55	55	Bioprosthesis	Hancock Standard Porcine Bioprosthesis
B11	Continued	B11	28	28	Bioprosthesis	Hancock II Porcine Bioprosthesis
B12	Continued	B12	29	29	Bioprosthesis	Hancock Modified Orifice Porcine Bioprosthesis
B13	Continued	B13	30	30	Bioprosthesis	Ionescu-Shiley Pericardial Bioprosthesis
B14	Continued	B14	31	31	Bioprosthesis	Labcor Stented Porcine Bioprosthesis
	Not Valid	B15	32		Bioprosthesis	Labcor Stentless Porcine Bioprosthesis
B33	New			81	Bioprosthesis	Labcor Stentless Porcine Bioprosthesis - Subcoronary
B34	New			82	Bioprosthesis	Labcor Stentless Porcine Bioprosthesis - Root
	Not Valid	B16	34		Bioprosthesis	Medtronic Freestyle Stentless Porcine Bioprosthesis
B35	New			83	Bioprosthesis	Medtronic Freestyle Stentless Porcine Bioprosthesis - Subcoronary
B36	New			84	Bioprosthesis	Medtronic Freestyle Stentless Porcine Bioprosthesis - Root
B17	Continued	B17	35	35	Bioprosthesis	Medtronic Intact Porcine Bioprosthesis
B18	Continued	B18	36	36	Bioprosthesis	Medtronic Mosaic Porcine Bioprosthesis
B37	New			85	Bioprosthesis	Medtronic Contegra Bovine Jugular Bioprosthesis
B19	Continued	B19	37	37	Bioprosthesis	Mitroflow Pericardial Bioprosthesis
B21	Continued	B21	39	39	Bioprosthesis	St. Jude Medical - Toronto SPV Stentless Porcine Bioprosthesis or SJM Toronto SPV Valve
B22	Continued	B22	40	40	Bioprosthesis	St. Jude Medical-Bioimplant Porcine Bioprosthesis
B38	New			86	Bioprosthesis	SJM Biocor Valve
B39	New			87	Bioprosthesis	SJM Epic Valve
B40	New			88	Bioprosthesis	SJM Toronto Root Bioprosthesis
B20	Continued	B20	38	38	Bioprosthesis	Sorin Pericarbon Stentless Pericardial Bioprosthesis
H6	New			89	Homograft	CryoLife Aortic Homograft
H7	New			90	Homograft	CryoLife Pulmonary Homograft
H8	New			91	Homograft	CryoLife CryoValve SG(Decellularized)Aortic Homograft
H9	New			92	Homograft	CryoLife CryoValve SG Pulmonary Homograft
H1	Continued	H1	41	41	Homograft	Homograft Aortic - Subcoronary
H2	Continued	H2	42	42	Homograft	Homograft Aortic - Root
H3	Continued	H3	43	43	Homograft	Homograft Mitral
H4	Continued	H4	44	44	Homograft	Homograft Pulmonic Root
	Not Valid	H5	56		Homograft	Cryolife Homotraft
H10	New			93	Homograft	LifeNet CV Allografts
A1	Continued	A1	45	45	Autograft	Pulmonary Autograft to aortic root (Ross Procedure)

R8	New			94	Ring - Annuloplasty	CarboMedics AnnuloFlo Ring
R9	New			95	Ring - Annuloplasty	CarboMedics AnnuloFlex Ring
R10	New			96	Ring - Annuloplasty	CarboMedics CardioFix Bovine Pericardium with PhotoFix Technology
R1	Continued	R1	46	46	Ring - Annuloplasty	Carpentier-Edwards Classic Annuloplasty Ring
R2	Continued	R2	47	47	Ring - Annuloplasty	Carpentier-Edwards Physio Annuloplasty System Ring
R3	Continued	R3	48	48	Ring - Annuloplasty	Cosgrove-Edwards Annuloplasty System Ring
R11	New			97	Ring - Annuloplasty	Edwards MC ³ Tricuspid Annuloplasty System G Future Band
R12	New			98	Ring - Annuloplasty	Genesee Sculptor Annuloplasty Ring
R4	Continued	R4	49	49	Ring - Annuloplasty	Medtronic Sculptor Ring
R5	Continued	R5	50	50	Ring - Annuloplasty	Medtronic-Duran AnCore Ring
R6	Continued	R6	51	51	Ring - Annuloplasty	Sorin-Puig-Messana Ring
R7	Continued	R7	52	52	Ring - Annuloplasty	St. Jude Medical Sequin Ring or SJM Séguin Annuloplasty Ring
R13	New			99	Ring - Annuloplasty	SJM Tailor Annuloplasty Ring
Ba1	New			100	Band - Annuloplasty	Medtronic Colvin Galloway Future Band
Ba2	New			101	Band - Annuloplasty	Medtronic Duran Band
Ba3	New			102	Band - Annuloplasty	Medtronic Duran - Ancore Band
777	Continued	777	777	777		Other

Appendix B: Procedure identification algorithm

Below is the algorithm that is used at the data warehouse to determine which procedure was performed. This is written in a computer program-like format specifically for the software developers.

If DataVrsn=2.35 or DataVrsn=2.41 then

If (OpTricus > 1 Or OpPulm > 1 Or OpONCard = 1 Or ONCAoAn = 1 Or ONCCarEn = 1 Or ONCOVasc = 1 Or ONCOThor = 1 Or OCarLVA = 1 Or OCarVSD = 1 Or OCarASD = 1 or OCarBati = 1 Or OCarSVR = 1 Or OCarCong = 1 Or OCarLasr = 1 Or OCarTrma = 1 Or OCarCrTx = 1 Or OCarAICD = 1 Or OCarOthr = 1) then

Procedure type is "Other"

Else

If OpCAB is "Yes" then

If OpAortic is missing or "No" then

If OpMitral is missing or "No" then

Procedure is "CAB Only"

Else

If OpMitral is "Replacement" then

Procedure is "MV Replacement + CAB"

Else

If OpMitral is "Annuloplasty only", or
"Reconstructions with annuloplasty", or
"Reconstruction without annuloplasty" then

Procedure is "MV Repair + CAB"

Else

If OpAortic is "Replacement" then

If OpMitral is missing or "No" then

Procedure is "AV Replacement + CAB"

Else

If OpAortic is missing or "No" then

If OpMitral is "Replacement" then

Procedure is "MV Replacement Only"

Else

If OpMitral is "Annuloplasty only", or
"Reconstruction with annuloplasty" or
"Reconstruction without annuloplasty" then

Procedure is "MV Repair"

Else

If OpAortic is "Replacement" then

If OpMitral is missing or "No" then

Procedure is "AV Replacement"

Else

If OpMitral = "Replacement" then

Procedure is "AV Replacement + MV Replacement"

If DataVrsn=2.52 then

If (OpTricus > 1 Or OpPulm > 1 Or OpONCard = 1 Or ONCAoAn = 1 Or
OCarLVA = 1 Or OCarVSD = 1 Or OCarASD = 1 Or OCarBati = 1 Or
OCarSVR = 1 Or OCarCong = 1 Or OCarLasr = 1 Or OCarTrma = 1 Or
OCarCrTx = 1 Or OCarAICD = 1 Or OCarOthr = 1 Or OCarAFib>1 or VAD=1) then
Procedure type is "Other"

Else

If OpCAB is "Yes" then

If OpAortic is missing or "No" then

If OpMitral is missing or "No" then

Procedure is "CAB Only"

Else

If OpMitral is "Replacement" then

Procedure is "MV Replacement + CAB"

Else

If OpMitral is "Annuloplasty only", or
"Reconstructions with annuloplasty", or
"Reconstruction without annuloplasty" then

Procedure is "MV Repair + CAB"

Else

If OpAortic is "Replacement" then

If OpMitral is missing or "No" then

Procedure is "AV Replacement + CAB"

Else

If OpAortic is missing or "No" then

If OpMitral is "Replacement" then

Procedure is "MV Replacement Only"

Else

If OpMitral is "Annuloplasty only", or
"Reconstruction with annuloplasty" or
"Reconstruction without annuloplasty" then

Procedure is "MV Repair"

Else

If OpAortic is "Replacement" then

If OpMitral is missing or "No" then

Procedure is "AV Replacement"

Else

If OpMitral = "Replacement" then

Procedure is "AV Replacement + MV Replacement"

Appendix C: Field ShortName and SeqNo by DataVrsn.

The following table lists all fields that have been collected in the STS Adult CV Database since 1999. The sequence number (SeqNo) of each field for a given version of the specifications is specified under the version number. If no sequence number is specified, the field was not a Core field for that version of the specifications.

ShortName	2.35	2.41	2.52
VendorID	10	10	10
SoftVrsn	20	20	20
DataVrsn	30	30	30
ParticID	40	40	40
RecordID	50	50	50
CostLink		52	60
STSTLink		54	70
PatID	60	60	80
RecComp	70	70	90
PatLName	80	80	100
PatFName	90	90	110
PatMInit	100	100	120
DOB	110	110	130
Age	120	120	140
Gender	130	130	150
SSN	140	140	160
MedRecN	150	150	170
PatZIP	190	190	180
Race	210	210	190
RefCard	220	220	200
RefPhys	250	250	210
HospName	280	280	220
HospZIP	282	282	230
HospStat	284	284	240
Payor	290	290	250
AdmitDt	320	320	260
SurgDt	330	330	270
DischDt	340	340	280
ICUVisit			300
ICUInHrs		354	310
ICUReadm		355	320
ICUAdHrs		356	330
TotHrICU		357	340
WeightKg	400	400	350
HeightCm	420	420	360
Smoker	440	440	370
SmokCurr	450	450	380
FHCAD	470	470	390
Diabetes	480	480	400
DiabCtrl	490	490	410
Hyprchol	510	510	420
CreatLst	550	525	430
RenFail	530	530	440
Dialysis	560	560	450

Hypertn	570	570	460
CVA	590	590	470
CVAWhen	600	600	480
InfEndo	610	610	490
InfEndTy	620	620	500
ChrLungD	660	660	510
ImmSupp	670	670	520
PVD	680	680	530
CVD	690	690	540
CVDType	700	700	550
Incidenc			560
PrCVInt	710	710	570
PrCAB	760	760	600
PrValve	770	770	610
PrOthCar	940	940	620
PrOCAICD			630
PrOCpace			640
POCPaceT			650
POCPCI			660
POCPCIIn			670
MI	1340	1340	750
MIWhen	1360	1360	760
CHF	1370	1370	770
Angina	1380	1380	780
AngType	1390	1390	790
CarShock	1420	1420	810
CarShTyp	1430	1430	820
Resusc	1440	1440	830
Arrhyth	1450	1450	840
ArrhyTyp	1460	1460	850
ClassNYH	1540	1540	870
MedBeta	1650	1650	890
MedACEI		1670	900
MedNitIV	1690	1690	910
MedACoag	1720	1720	930
MedACMN			940
MedCoum			950
MedInotr	1740	1740	970
MedSter	1750	1750	980
MedASA	1760	1760	990
MedLipid			1000
MedLipMN			1010
MedADPI			1020
MedGP			1030
MedGPMN			1040
NumDisV	1820	1820	1050
LMainDis	1830	1830	1060
HDEFD		1858	1070
HDEF	1860	1860	1080
HDEFMeth	1870	1870	1090
HDPAD		1915	1100
HDPAMean	1940	1940	1110
VDStenA	2010	2010	1120

VDGradA		2015	1130
VDStenM	2020	2020	1140
VDStenT	2030	2030	1150
VDStenP	2040	2040	1160
VDInsufA	2050	2050	1170
VDInsufM	2060	2060	1180
VDInsufT	2070	2070	1190
VDInsufP	2080	2080	1200
Surgeon	2230	2230	1210
SurgID			1220
Status	2300	2300	1240
UrgntRsn	2310	2310	1250
EmergRsn	2320	2320	1260
Robotic			1270
OpCAB	2340	2340	1280
OpValve			1290
VAD	4550	4550	1300
OpOCard	2510	2510	1310
OpONCard	2520	2520	1320
SISstartT		4347	1330
SISstopT		4348	1340
CPBUtil			1350
CPBCmb			1360
CPBCmbR			1370
PerfusTm	4360	4360	1380
Cannulat	3760	3760	1390
AortOccl	3880	3880	1400
XClampTm	4350	4350	1410
Cplegia	4380	4380	1420
IABP	4480	4480	1430
IABPWhen	4490	4490	1440
IABPInd	4500	4500	1450
IBldProd			1460
IBdRBCU			1470
IBdFFPU			1480
IBdCryoU			1490
IBdPlatU			1500
DistArt	2570	2570	1520
DistVein	2580	2580	1530
AnasDevU			1540
AnasDev			1550
IMAArtUs	2590	2590	1560
IMATechn	4070	4070	1570
NumIMADA	2660	2660	1580
RadArtUs	2670	2670	1590
NumRadDA	2680	2680	1600
NumGEPDA	2700	2700	1610
NumOArtD			1620
OpAortic	2350	2350	1630
OpMitral	2360	2360	1640
OpTricus	2370	2370	1650
OpPulm	2380	2380	1660
AnlrEnl			1670

VSAoImTy	3240	3240	1680
VSAoIm	3250	3250	1690
VSAoImSz	3260	3260	1700
VSMiImTy	3300	3300	1740
VSMiIm	3310	3310	1750
VSMiImSz	3320	3320	1760
VSTrImTy	3360	3360	1800
VSTrIm	3370	3370	1810
VSTrImSz	3380	3380	1820
VSPuImTy	3420	3420	1860
VSPuIm	3430	3430	1870
VSPuImSz	3440	3440	1880
PrevVAD			1920
VADInd			1930
IntPVAD			1940
HPVPCWP			1950
HPVCVP			1960
HPVPVR			1970
HPVCI			1980
HPVRVEF			1990
HPVRVMth			2000
HPVPVO2M			2010
HPVPVO2			2020
VImpTy			2030
VProdTy			2040
VImpDt			2050
VExp			2060
VExpDt			2070
VExpRsn			2080
VCardTx			2090
VTxDt			2100
LVADInf			2110
RVADInf			2120
VImpTy2			2130
VProdTy2			2140
VImpDt2			2150
VExp2			2160
VExpDt2			2170
VExpRsn2			2180
VCardTx2			2190
VTxDt2			2200
VImpTy3			2210
VProdTy3			2220
VImpDt3			2230
VExp3			2240
VExpDt3			2250
VExpRsn3			2260
VCardTx3			2270
VTxDt3			2280
PVCmpBld			2290
PVCmpESt			2300
PVCmpDCI			2310
PVCmpPPI			2320

PVCmpEnd			2330
PVCmpMal			2340
VADDiscS			2350
OCarLVA	4150	4150	2360
OCarVSD	4160	4160	2370
OCarASD	4170	4170	2380
OCarBati	4180	4180	2390
OCarSVR		4185	2400
OCarCong	4190	4190	2410
OCarLasr	4200	4200	2420
OCarTrma	4210	4210	2430
OCarCrTx	4220	4220	2440
OCarACD			2450
OCarACDL			2460
OCarAFib			2470
OCarAFES			2480
ONCAoAn	4260	4260	2510
ONCAsc			2520
ONCArch			2530
ONCDesc			2540
ONCThAbd			2550
OCarOthr	4250	4250	2560
ONCCarEn	4320	4320	2570
ONCOVasc	4330	4330	2580
ONCOThor	4340	4340	2590
ONCOther			2600
BldProd	4630	4630	2610
BdRBCU			2620
BdFFPU			2630
BdCryoU			2640
BdPlatU			2650
ExtubOR			2660
VentHrsI		4676	2670
ReIntub		4678	2680
VentHrsA		4679	2690
VentHrs	4680	4680	2700
Complics	4760	4760	2710
COPReBld	4840	4840	2720
COPReVlv	4850	4850	2730
COPReGft	4860	4860	2740
COPReOth	4870	4870	2750
COPReNon	4880	4880	2760
COPPerMI	4890	4890	2770
CIStDeep	4920	4920	2780
CIThor	4930	4930	2790
CILeg	4940	4940	2800
CISeptic	4960	4960	2810
CNStrokP	5000	5000	2830
CNStrokT	5010	5010	2840
CNComa	5030	5030	2850
CPVntLng	5050	5050	2860
CPPulEmb	5070	5070	2870
CPPneum	5100	5100	2880

CRenFail	5120	5120	2890
CRenDial		5130	2900
CVaIIFem	5230	5230	2910
CVaLbIsc	5240	5240	2920
COtHtBlk	5260	5260	2930
COtArrst	5270	5270	2940
COtCoag	5280	5280	2950
COtTamp	5290	5290	2960
COtGI	5300	5300	2970
COtMSF	5310	5310	2980
COtAFib	5320	5320	2990
CVaAoDis	5220	5220	3000
COtOther			3010
Mortality		5337	3020
MtDCStat	5340	5340	3030
Mt30Stat	5350	5350	3040
MtOpD	5400	5355	3050
MtDate	5360	5360	3060
MtLocatn	5370	5370	3070
MtCause	5380	5380	3080
DCADP			3090
DCAArhy			3100
DCAArMN			3110
DCASA		5331	3120
DCACE		5332	3130
DCBeta		5333	3140
DCLipid		5334	3150
DCLipMT			3160
DCCoum			3180
DisLoctn		5336	3190
CardRef			3200
SmokCoun			3210
Readm30	5500	5500	3220
ReadmRsn	5510	5510	3230
ReadmPro			3240
PredMort	2530	5610	3250
PredDeep		5620	3260
PredReop		5630	3270
PredStro		5640	3280
PredVent		5650	3290
PredRenF		5660	3300
PredMM		5670	3310
Pred6D		5680	3320
Pred14D		5690	3330
DCAntPlt		5335	
IndMnInv	3480	3480	
CnvStdIn	3510	3510	
ConvCPB		3479	
CorShunt	3930	3930	
OCarPace	4230	4230	
PrPTCA	1160	1160	
ClassCCS	1530	1530	
NumIncis	3500	3500	

OpMinInv	2500		
MedDiur	1730	1730	
MedDig	1640	1640	
MedAPlt		1710	
IschTRCA	3960		
IschTLAD	3950		
IschTCFX	3970		
CPBUsed	3750	3478	
PrCBNum	740	740	
PrPTIntv	1190	1190	
PrNSStnt	1230	1230	
PrNSBall	1280	1280	
PrimInc	3490	3490	
CABUnpln	2550	2550	
CIUTI	4970	4970	
CnvIndic	3520	3520	
PrCNNum	750	750	
OCarAICD	4240	4240	
SameDay	350	350	
StntIntv		1235	
SurgGrp	2235	2235	
SutrTech	4040	4040	
ThrIntvl	1260	1260	
Thrmblys	1240	1240	
AngUnstT	1400	1400	
VSAoExSz	3290	3290	
VSTrEx	3400	3400	
VSTrExTy	3390	3390	
VSPuExSz	3470	3470	
VslStblz	4050	4050	
VSTrExSz	3410	3410	
VSAoExTy	3270	3270	
VSAoEx	3280	3280	
VSMiExSz	3350	3350	
VSMiExTy	3330	3330	
FlowPtcy	4080	4080	
VSPuEx	3460	3460	
VSPuExTy	3450	3450	
VSMiEx	3340	3340	

Appendix D: Vendor recommendations

The following is a list of ideas software developers might want to include in their software. These utilities are not required, but many users have suggested that having these abilities would greatly enhance the usefulness of their software. It is entirely up to the software developer to determine whether they have the time and resource to add these features to their product.

1. Add additional fields for Body Surface Area (BSA) and Body Mass Index (BMI).

BSA is a standard calculation that allows for a definition of overweight while taking into account the height and weight of the person. Risk models may use this calculation combined with gender.

Various BSA formulas have been developed. The STS warehouse applies the following calculation for risk model application:

$$\mathbf{BSA(m^2) = 0.007184 \times HeightCm^{0.725} \times WeightKg^{0.425}}$$

(DuBois D; DuBois EF: A formula to estimate the approximate surface area if height and weight be known. Arch Int Med 1916 17:863-71.)

The BMI calculation follows:

$$\mathbf{BMI = (WeightKg)/(HeightCm/100)^2}$$

2. Include an O/E ratio in site reports. This is the ratio of observed mortalities to expected mortalities for a given group.

A patient's predicted risk for mortality is calculated using the current standard STS risk calculation and retained in the PredMort field for each patient.

The Expected mortality (E) for a group is calculated by summing the PredMort for each observation in a subgroup and dividing by N (the number of procedures in that group).

The Observed mortality (O) for the same group is calculated by adding the number observed or actual mortality for each procedure in a subgroup and dividing by N.

The O/E ration is the Observed result divided by the Expected result and represented as a number (usually with one decimal place).

An O/E ratio greater than 1.0 means that the group had more deaths occur than was expected. An O/E ratio less than 1.0 means that the group had fewer deaths occur than were expected. 95% confidence intervals should be displayed with this number if possible.

Note: in the twice annual STS participant specific reports, when a participant's number of cases falls below 50 for CAB cases or below 10 for Valve or CAB+Valve cases, the report flags that the ratio is unstable.

- The warehouse requires each participant to submit a harvest verification report to the warehouse each time a data file is submitted. This report specifies the number of procedures done each year for each type of procedure. The report breaks out only the five procedure types that are included in the national analysis reports and combines all other types of procedures into an "other" category (the algorithm for determining the procedure type is defined in Appendix B). In addition, the report contains the total number of procedures for each year as well as the number of deaths for each year. We have found that this 'handshake' between the participants and the warehouse highlights and reduces transfer errors. Participants may request the vendor support their efforts to produce this report through an automated query or report.

The information requested in the form includes:

	Begin Date - End Date Year 1 *	Begin Date - End Date Year 2	Begin Date - End Date Year 3 *
CAB	N	N	N
AVR	N	N	N
MVR	N	N	N
CAB+AVR	N	N	N
CAB+MVR	N	N	N
Other	N	N	N
Totals Procedures	N	N	N
Mortalities	N	N	N

*Year 1 and Year 3 are half years during each Fall harvest.
Only Year 1 and Year 2 are needed during Spring Harvests.

It is also recommended that software developers should NOT try to make their report look exactly like the form sent to the warehouse as this form may change in appearance from one harvest to the next and it would create too much of a burden to try to keep the forms identical.

- Provide the site level ability to flag missing data. Many participants have requested the ability to enter codes to indicate why data values are missing (N/A, ND, -9, etc.). This would allow the site to flag the lack of availability of the data and reduce the number of data quality warnings they get at the site.

The data specifications are designed to control the values that are exported from the sites data and submitted to the data warehouse. They are not intended to control what values are stored at the site level. Additional codes can be recorded at the site as long as they are converted to the standard value for the warehouse upon export. In the case of missing data codes, this would mean converting the data to nulls. It is important to

note that the warehouse does not make use of missing codes and receipt of them will cause the file to be in error.

Also note that the warehouse will still report the percent missing in certain fields via the Data Quality Report. The warehouse does not differentiate the reasons for the data not being available and only reports on the amount of data that is missing.

5. Include in the data quality checks procedures a converse check for children of a 'grouping' parent in that at least one child should be present if the parent is checked as Yes.
6. When the user selects the name of the hospital (HospName) from the drop down list, automatically fill in the hospital postal code (HospZip) and state (HospStat). The postal code and state of the hospital could be collected in the same utility in which the hospital names are defined.
7. Perform a check for patients who die in the hospital without having any complications checked. Also provide a count or percentage of how many records have no complications.
8. Some hospitals have surgeons working at them that do not want to have their data submitted to the data warehouse. Developers can give the users the option of flagging which surgeon names should be included in the export for submission to the data warehouse. This information could be collected in the same utility in which the surgeon names are defined. However, if this utility is included, by default all surgeons should be included in the extract and users have to explicitly state that particular surgeons should not be included.

Hospitals might also enter other records into their database that should not be included in the data harvest. To allow for this, developers can create a harvest flag that can be marked Yes or No to indicate whether or not the record should be included in the STS data extract. If this method is used, the value of this field must default to Yes to allow the records to be included in the harvest.

9. Identify patients who are under 20 years of age during the data quality check procedures. Patients who are under 20 can be included in the harvested data file, but they will not be included in the national analysis done by the data warehouse.
10. Include in the data quality checking routine the same consistency checks that are performed at the data warehouse. These checks are described in Appendix E.

Appendix E: Consistency edits

The following is a description of the consistency checks that are performed on each site's data at the data warehouse. These are additional checks that compare variable values for clinical correctness. It is recommended that software developers include these checks in their own quality control routines so that any issues can be resolved before data is submitted to the warehouse. This will also help insure that the data at the warehouse accurately reflects the data at the site.

1. MI
 - a. If (MI is missing or MI<>Yes) and Status=Urgent and UrgntRsn=AMI, then set MI=Yes
 - b. If (MI is missing or MI<>Yes) and Status=Emergent and EmergRsn=AEMI, then set MI=Yes
2. AngType
 - a. If (AngType is missing or AngType<>Unstable) and Status=Urgent and UrgntRsn=USA, then set AngType=Unstable.
3. NumDisV
 - a. If (NumDisV is missing or NumDisV = None or NumDisV=One) and LMainDis=Yes, then set NumDisV=Two.
4. DistArt
 - a. If (NumIMADA>=1 or NumRadDA>=1 or NumGEPDA>=1 or NumOArtD>=1) and DistArt<NumIMADA + NumRadDA + NumGEPDA + NumOArtD, then set DistArt=NumIMADA + NumRadDA + NumGEPDA + NumOArtD.
5. MtOpD
 - a. If (MtOpD is missing or MtOpD=No) and MtDCStat=Dead and MtDate<=DischDt, then set MtOpD=Yes.
 - b. If MtOpD is missing and Mt30Stat=Dead, then set MtOpD=Yes.
 - c. (Note here that a. will overwrite the value of MtOpD if it is missing or No, but b. will only overwrite the value of MtOpD if it is missing).
6. Age
 - a. If Age is missing or the current value of Age does not equal the number of months between the DOB and SurgDt divided by 12, then set Age to this calculated value.
7. TotHrICU
 - a. If ICUInHrs contains a valid value or ICUAdHrs contains a valid value, then set TotHrICU to ICUInHrs + ICUAdHrs if it does not already equal that value. Care must be taken when doing this calculation to handle the situation where one of the values is missing.
8. VentHrs
 - a. If VentHrsI contains a valid value or VentHrsA contains a valid value, then set VentHrs to VentHrsI + VentHrsA if it does not already equal that value. Care must be taken when doing this calculation to handle the situation where one of the values is missing.
9. Order of date fields
 - a. If DOB, AdmitDt, SurgDt, DischDt, and MtDate are not in chronological order, make no changes to the data, but warn the user that the data are incorrect.

- b. In the VAD section, the implant, explant and transplant dates for the initial implant as well as the two additional implants should all be in chronological order and should all be between the AdmitDt and DischDt. These fields include: VImpDt, VExpDt, VTxDt, VImpDt2, VExpDt2, VTxDt2, VImpDt3, VExpDt3, and VTxDt3. If any of these fields do not meet that criteria, make no changes to the data, but warn the user that the dates are incorrect.