REPORT OF THE
STATE EMERGENCY MEDICAL SERVICES
ADVISORY BOARD ON

MANAGEMENT OF PATIENT CARE REPORTS IN VIRGINIA'S PRE-HOSPITAL SETTING

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

HOUSE DOCUMENT NO. 72

COMMONWEALTH OF VIRGINIA
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COMMONWEALTH of VIRGINIA

Department of Health
Office of Emergency Medical Services

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December 15, 1997

TO: The Honorable George Allen
Governor of Virginia

Members of the General Assembly of Virginia

I am pleased to submit the Report of the State EMS Advisory Board on the Management of Patient Care Reports in Virginia's Pre-Hospital Setting pursuant to House Joint Resolution 637.

Respectfully submitted,

Robert G. Powell, M.D., Chairman
State EMS Advisory Board

Management of Patient Care Reports in Virginia's Pre-Hospital Setting

Executive Summary

The 1997 General Assembly requested that the State Emergency Medical Services (EMS) Advisory Board conduct a pilot study to help assess the performance of Virginia's EMS system and to assist in planning future policy and funding. In accordance with HJR 637 guidelines, 50 EMS agencies, representing each of the Office of EMS's eight regions, were invited to participate in a study of the Management of Pre-Hospital Patient Care Reports in Virginia's Pre-Hospital Setting. The selection included volunteer, paid, rural and urban agencies. They were offered an incentive of $100 each for providing copies of their PPCR forms relating to cardiac arrest calls for three months (April 1996, November 1996 and January 1997). Five additional agencies were identified as alternates.

The State EMS Advisory Board charged the Office of OEMS with the coordination of this pilot study. The Office of EMS contracted with Virginia Health Information, Inc., (VHI) for tabulation, analysis and reporting of the data obtained from the PPCR forms. Tabulation and analysis were conducted so results were given as comparisons and statistical significance. Participation by EMS agencies in the pilot study was moderate as 39 of the 55 agencies selected (70.9%) sent in their PPCR data for the three months requested.

Significant findings of the study showed that:

- An effective system does not exist to tabulate statewide information on emergency services runs, e.g., response times, transport times, outcomes or the nature of the calls, and what percentage of the calls are cardiac, burn or accident related.

- Analysis of the data did provide valuable information to measure response and transport times and the results of emergency calls, and help identify deficiencies that need to be addressed. It would also provide agency and technician information on medical direction for Operational Medical Directors. Information not currently available that could be critical to localities and the state in seeking federal grants could be provided.

- Based on the small amount of error in data entry (less than 2%), the information given is promising in reflection of the type of further studies that could be done within data entry for EMS. Further projects with larger sampling sizes could provide useful information on pre-hospital cardiac arrest patients or other medical issues, as well as performance information on individual EMS agencies and the Virginia EMS system.

- The "snapshot" information gathered from this study can be used to initiate the development of a practical approach to gather the information needed to increase survival rates.

Due to the small size, limited time frame and data entry constraints of this pilot study, major

changes in EMS life support policies and procedures on either a state or local level are not recommended. The Office of EMS should continue to stress the implementation and/or continuation of quality assurance and improvement programs within EMS agencies in order to ensure that PPCR forms are accurately and completely filled out. This recommendation may help to alleviate any inaccurate information that gets keyed into other programs that may be developed. It would also help to identify any patient care issues that may arise.

The study determined that further analysis needs to be conducted to address the following questions:

- What is the purpose of collecting the pre-hospital care data - monitor performance, allocate resources, research, legal record keeping, policy development?
- What is the feasibility of developing a unified PPCR reporting and evaluation system?
- What is the most efficient and effective way to collect input, analyze data and assure data quality?
- What type of incentives can help assure participation and cooperation by EMS agencies?
- What effect will their participation and the development of a unified data entry system have on EMS agencies?

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Management of Patient Care Reports in Virginia's Pre-Hospital Setting

A Report by
The State Emergency Medical Services Advisory Board
January 14, 1998

Authority for Study - House Joint Resolution 637

The 1997 General Assembly requested that the State Emergency Medical Services (EMS) Advisory Board conduct a pilot study to help assess the performance of Virginia's EMS system and to assist in planning future policy and funding (See Appendix A). This was done through the collection and analysis of statewide data on cardiac arrest calls for three months. The data on resuscitation activities to cardiac arrest patients were taken from the pre-hospital patient care reports (PPCR) submitted by up to 50 EMS agencies across the Commonwealth of Virginia.

The State EMS Advisory Board charged the Office of OEMS with the coordination of this pilot study.

Background

"There is no central database at the national (or state) level that relates to the current practice of EMS. The data required to completely describe an EMS event exists in separate disparate locations. These include EMS agencies, emergency departments, hospital medical records, other public safety agencies and vital statistics offices. In most cases, meaningful linkages between such sites are nonexistent," reports the U. S. Department of Health & Human Resources and the U. S. Department of Transportation in their joint publication - EMS Agenda for The Future (See Appendix B).

The purpose of collecting EMS data is to evaluate the emergency medical care of individuals with illnesses and injuries in an effort to improve access and reduce morbidity and mortality. The lack of organized information systems that produce data which are valid, reliable and accurate is a significant barrier to coordinating EMS system evaluation, including outcomes analyses.

The Virginia General Assembly passed legislation in 1987 that required all licensed EMS agencies to submit pre-hospital patient care data to the Virginia Department of Health (VDH) (See Appendix C). Since then the following has been initiated:

- The VDH Office of Emergency Medical Services designed Pre-Hospital Patient Care Report (PPCR) forms and continues to provide these free to any agency that wishes to use this standard form. EMS agencies can also use their own form if it contains the minimum data set.

- VDH contracted with the Department of Information Technology (DIT) to design and develop an information system program to enter data from the field and to generate quarterly reports for VDH and the EMS agencies. As the automated design progressed, deficiencies were identified in the timeliness of producing full reports, accuracy and cost of data entry. In 1990, DIT advised VDH that it would cost DIT $1 million per year to correct these deficiencies and produce the information that could most effectively be used

by VDH and the EMS agencies.

- Since this program was an unfunded mandate, further development of the PPCR system was delayed until additional funds could be identified. Federal funds were not available to accomplish the full project. State Two for Life Funds could not be used without eliminating some of the existing programs and services of the Office of EMS. A budget addendum for the 1994-96 budget was considered but ultimately not included in VDH's priorities or in the Secretary of Health and Human Resources recommendations.

- EMS agencies were notified to discontinue submitting copies of their PPCR forms. However, agencies were told that it was important that they continue to "prepare and maintain complete and accurate patient care reports for submission to the receiving hospital and for their agency's records for medical/legal purposes."

- The Office of EMS is now working with sophisticated automation capabilities which were not available in the early 1990s. This and the decision to process only automated PPCR reports, eliminating paper reports, will help accomplish a fully automated PPCR system.

- VDH has conducted a survey of all EMS agencies to evaluate their automation capabilities as related to PPCR. Seventy-two percent of the agencies responding had no automation capabilities.

- The Office of EMS has identified the development and implementation of a statewide automated pre-hospital patient care reporting system as a priority in its 1997-2002 five-year plan. In preparation for this, EMS agencies have been requested to participate in the identification of the data elements to be included in the Virginia Uniform EMS Data Element Dictionary being developed by the State EMS Advisory Board. Also, for agencies without automation capabilities, OEMS is developing a scannable PPCR form.

- In late 1997, VDH received a $40,000 federal Highway Safety Grant to re-engineer/update the EMS automated Quality Assurance Program so EMS agencies can submit PPCR data electronically.

Methodology for HJR 637 Study

In 1997, in accordance with HJR 637 guidelines, 50 EMS agencies, representing each of the Office of EMS's eight regions, were invited to participate in a study of the Management of Pre-Hospital Patient Care Reports in Virginia's Pre-Hospital Setting. The selection included volunteer, paid, rural and urban agencies. They were offered an incentive of $100 each for providing copies of their PPCR forms relating to cardiac arrest calls for three months (April 1996, November 1996 and January 1997). Five additional agencies were identified as alternates.

The Office of EMS contracted with Virginia Health Information, Inc., (VHI) for tabulation, analysis and reporting of the data obtained from the PPCR forms for April 1996, November 1996 and January 1997. Tabulation and analysis were conducted so results were given as comparisons and statistical significance.

Some of the variables in the study included: age, race and sex of patient; time call received, time arrive scene and time arrive destination; resuscitation attempted; life support provided; if the patient received CPR from a bystander; and if the EMS personnel were the first emergency units to respond. Frequencies of different procedures performed by paid and volunteer agencies were compared (See Appendix D).

Participation by EMS agencies in the pilot study was moderate as 39 of the 55 agencies selected (70.9%) sent in their PPCR data for the three months requested. Of the 519 total PPCRs received, 514 were used for the data entry. Approximately 130 additional reports were collected that could not be included in the final count because they either did not meet the cardiac arrest criteria (i.e., inappropriate medical complaint or traumatic cardiac arrest), were incomplete, inaccurate or difficult to read.

One of the agencies selected submitted a large number of patient care reports for data entry, however, none of these could be used because they were computer generated, not based on the standard PPCR form and did not include all of the data entry parameters required for analysis.

Findings

Significant findings of the study showed that:

1. An effective system does not exist to tabulate statewide information on emergency services runs, e.g., response times, transport times, outcomes or the nature of the calls, and what percentage of the calls are cardiac, burn or accident related.

2. Analysis of the data did provide valuable information to measure response and transport times and the results of emergency calls, and help identify deficiencies that need to be addressed. It would also provide agency and technician information on medical direction for Operational

Medical Directors. Information not currently available that could be critical to localities and the state in seeking federal grants could be provided.

3. Based on the small amount of error in data entry (less than 2%), the information given is promising in reflection of the type of further studies that could be done within data entry for EMS. Further projects with larger sampling sizes could provide useful information on pre-hospital cardiac arrest patients or other medical issues, as well as performance information on individual EMS agencies and the Virginia EMS system.

4. The "snapshot" information gathered from this study can be used to initiate the development of a practical approach to gather the information needed to increase survival rates.

Recommendations

- Due to the small size, limited time frame and data entry constraints of this pilot study, major changes in EMS life support policies and procedures on either a state or local level are not recommended.

- The Office of EMS should stress the implementation and/or continuation of quality assurance and improvement programs within EMS agencies in order to ensure that PPCR forms are accurately and completely filled out. This recommendation may help to alleviate any inaccurate information that gets keyed into other programs that may be developed. It would also help to identify any patient care issues that may arise.

- Further analysis needs to be conducted to address the following questions:

    - What is the purpose of collecting the pre-hospital care data - monitor performance, allocate resources, research, legal record keeping, policy development?

- What is the feasibility of developing a unified PPCR reporting and evaluation system?

- What is the most efficient and effective way to collect input, analyze data and assure data quality?

- What type of incentives can help assure participation and cooperation by EMS agencies?

- What effect will their participation and the development of a unified data entry system have on EMS agencies?

APPENDIX A

HOUSE JOINT RESOLUTION NO. 637

Requesting the State Emergency Medical Services Advisory Board to conduct a pilot study relating to prehospital care data.

Agreed to by the House of Delegates, February 4, 1997
Agreed to by the Senate. February 19, 1997

WHEREAS, although the Commonwealth has had, since 1987, a legal mechanism for collecting prehospital patient care data in Article 3.1 (32.1-116.1 et se.) of Chapter 4 of Title 32.1, this program has never been fully planned and designed; and

WHEREAS, as a result, no system presently exists to tabulate the statewide information on emergency services runs, e.g., response times, transport times, and outcomes or the nature of the calls, and what percentage of the calls are cardiac-related, burn-related, or accident-related; and

WHEREAS, analysis of these data would provide valuable information to measure the response times, transport times, and results of the emergency calls and to take steps to remedy any deficiencies; and

WHEREAS, frequently, treatment during the "golden hour" after the injury or stroke or heart attack makes the difference between recovery and life-long disability or death; and

WHEREAS, data on the EMS system--for example, snapshot information--could demonstrate the need, or lack thereof, to collect and analyze statewide statistics on the delivery of emergency services in order to assess the performance of the EMS system and to plan for the future in terms of policy and funding; and

WHEREAS, snapshot information could also be used to initiate the development of a practical approach to gather this needed information in order to increase survival rates; and

WHEREAS, the Board of Health is charged with developing a comprehensive EMS system in Virginia and with reducing the time between the identification of an acutely ill or injured patient and the definitive treatment;

WHEREAS, the State Emergency Medical Services Advisory Board is charged with advising the Board of Health in matters pertaining to the effective implementation of a comprehensive EMS system in the Commonwealth; now, therefore, be it

RESOLVED by the House of Delegates, the Senate concurring , That the State Emergency Medical Services Advisory Board be requested to conduct a pilot study relating to prehospital care data. The EMS Advisory Board shall, consistent with any language and funding provided in the appropriation act, implement this pilot study as follows: (i) the EMS Advisory Board shall request no more than 50 emergency services providers, configured by participation of four

agencies from each region, to volunteer to provide copies of the prehospital patient care report (PPCR) forms relating to cardiac arrest calls for three months, such months to be determined by the Advisory Board, to a data analysis contractor; (ii) as an encouragement for the local squads to cooperate in this data collection , the Advisory Board shall, with such funds as may be provided for this purpose, offer incentives of $100 to each of the up to fifty squads who volunteer to provide the information; and (iii) the Advisory Board shall contract with Virginia Health Information, Inc., for a fee of no more than $12,000, for tabulation, analysis, and reporting of the data obtained from the PPCR forms.

The State Emergency Medical Services Advisory Board shall complete its work in time to submit its findings and recommendations to the Governor and the 1998 Session of the General Assembly as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents.

APPENDIX B

Excerpts from
EMS AGENDA FOR THE FUTURE
a publication of the
U. S. Department of Health and Human Resources
and
U. S. Department of Transportation

APPENDIX C

Code of Virginia § 32.1-116.1

Prehospital patient care reporting procedure; trauma registry; confidentiality

A. In order to collect data on the incidence, severity and cause of trauma, integrate the information available from other state agencies on trauma and improve the delivery of prehospital and hospital emergency medical services, there is hereby established the Emergency Medical
Services Patient Care Information System. The Emergency Medical Services Patient Care Information System shall include the prehospital patient care reporting procedure and the trauma registry.

All licensed emergency medical services agencies shall participate in the prehospital patient care reporting procedure by making available to the Commissioner or his designees the minimum data set on forms prescribed by the Board or locally developed forms which contain equivalent information. The minimum data set shall include, but not be limited to, type of medical emergency or nature of the call, the response time, the treatment provided and other items as prescribed by
the Board.

The Commissioner may delegate the responsibility for collection of this data to the Regional Emergency Medical Services Councils, Department of Health personnel or individuals under contract to the Department. The Advisory Board shall assist in the design, implementation, subsequent revisions and analyses of the data of the prehospital patient care
reporting procedures.

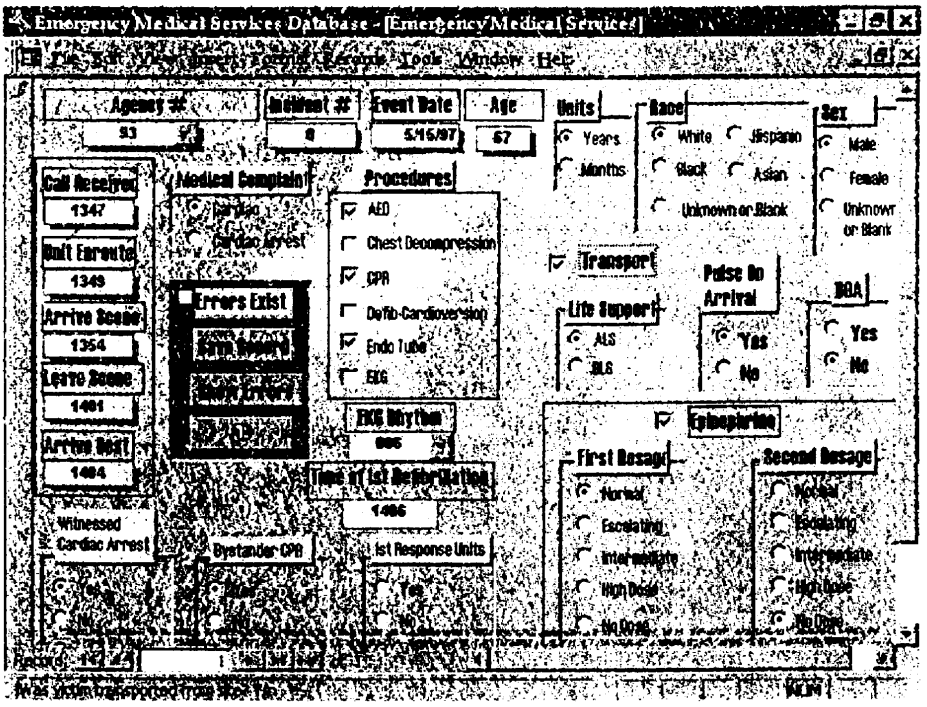
B. All licensed hospitals which render emergency medical services shall participate in the trauma registry by making available to the Commissioner or his designees abstracts of the records of all patients admitted to the institutions' trauma and general surgery services with a diagnoses related to trauma. The abstracts shall be submitted on forms provided by the Department and shall include the minimum data set prescribed by the Board.

The Commissioner shall seek the advice and assistance of the Advisory Board and the Committee on Trauma of the Virginia Chapter of the American College of Surgeons in the design, implementation, subsequent revisions and analyses of the trauma registry.

APPENDIX D

Virginia Health Information

Cardiac Arrest Pilot Study



Developed by
Virginia Health Information

Pursuant to
House Joint Resolution 637

Passed by
Virginia's General Assembly

Developed Specifically for the

Office of Emergency Medical Services

Reports Generated by

Virginia Health Information
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If data is reformatted or redistributed, the Office of Emergency Medical Services agreed to include the following statement with any redistribution of this report:

"Virginia Health Information(VHI) has provided non-confidential patient level information used in this report which was compiled in accordance with Virginia law. VHI has no authority to independently verify this data. By accepting this report the requester agrees to assume all risks that may be associated with or arise from the use of inaccurately submitted data. VHI edits data received and is responsible for the accuracy of assembling this information, but does not represent that the subsequent use of this data was appropriate or endorse or support any conclusions or references that may be drawn from the use of this data."

Executive Summary

This Cardiac Arrest Pilot Study was envisioned to investigate the potential use of data collected by Emergency Medical Service (EMS) agencies to provide a better understanding of the care rendered to victims of sudden cardiac arrest. Virginia Health Information (VHI) found that the data could be used to serve this purpose.

In conducting this study there were a number of accomplishments:

- ✓ The Office of Emergency Medical Services (OEMS) was effective in their efforts to recruit EMS agencies to voluntarily submit copies of Pre-hospital Patient Care Report forms (PPCR).
- ✓ VHI designed a computer-based electronic data entry system for the study that effectively collected and edited the data. From this system a database was created for analysis.
- ✓ OEMS personnel were able to design reports for VHI programming and analysis that identified key areas of their interest.
- ✓ Analysis of reports produced indicated some statistically significant differences between types of victims seen by agencies as well as some of the methods employed. While the sample selected for this study does not allow results to be generalized to all agencies or care provided, results do point to promising areas for future study.
- ✓ Areas where data was missing or incomplete were identified. These areas can be used to improve the accuracy of data for future studies.
- ✓ A more comprehensive look at the outcomes of care provided to sudden cardiac arrest patients can be made if data submitted can be linked to available hospital discharge information and state mortality information. Accomplishing this requires additional efforts to ensure that patient identifiers are collected by EMS agencies on the PPCR forms.

As a demonstration project, the goals were not to answer clinical research questions or to make generalizations about what treatments or organizations result in the best patient outcomes. The goal was to determine whether these questions *could* be answered using this type of data in the future. The answer is a qualified yes. If future studies include a larger and statistically reliable sample and a process for incremental improvements in the data collected, this data can accomplish those goals.

Background

Sudden cardiac arrest caused over 2,700 hospital admissions in Virginia in 1996. Many victims of sudden cardiac arrest die before reaching the hospital, succumbing to the devastating effects of the cardiac arrest before life-saving treatment can be provided in those critical moments following cardiac arrest.

Volunteer rescue squads and private ambulance services collect data on paper forms for all medical emergency calls made in Virginia. This pilot study on sudden cardiac arrest is a collaborative effort between the Virginia OEMS and VHI to use information

collected to gain a better understanding of emergency medical services provided to victims of sudden cardiac arrest.

VHI was asked to perform a series of tasks. The first was to develop a data entry system designed for cardiac arrest care data using paper copies of PPCR forms. This system was required to edit the data at the time of entry. Once the entry system was developed and tested, data from the PPCR forms were entered, edited, and appended to a database for analysis. Following creation of the dataset, a series of reports, analyses, and summaries were requested. As part of the analysis, VHI was asked to critique the utility of the PPCR forms for the evaluation of services provided by EMS agencies and as a vehicle for the analysis of optimum treatment methods for various conditions.

VHI formed a team to accomplish these tasks. Commonwealth Clinical Systems, Inc. of Charlottesville, Virginia developed computer programs according to VHI specifications and designed a data-entry system. VHI was responsible for project management and oversaw the data entry, editing, and creation of the database. Following entry of data, a series of data validation checks and reports were designed and applied. Results from this preliminary analysis were provided to OEMS staff for guidance and direction for subsequent analysis. A report writing phase was conducted with the assistance of a contractor, Richard L. Walker, and VHI staff, Kim S. Jones, M.S. Detailed analysis of the reports was conducted by Henry F. Inman, Ph.D., an independent biostatistician from Richmond, Virginia. VHI brought these resources together in a coordinated effort to meet OEMS needs within the short timeframe established for the study.

Study Design

OEMS personnel chose to identify sudden cardiac arrest cases occurring during the months of April and November 1996 and January 1997. Participation by EMS agencies in this study was voluntary. PPCR forms are kept at each agency. Because of limited agency resources, it was expected that not all agencies would be able to participate in the study. For this reason OEMS personnel invited over 50 agencies to participate in the project. The sample included agencies from all geographic regions. Roughly half of the invited agencies were volunteer, the other half being private/paid or a combination of volunteer and private. A total of 53 agencies actually participated; 28 of the agencies were volunteer, 14 were private/paid, and 11 were combination. OEMS personnel forwarded a total of 519 forms to VHI for entry of which 514 were used in the analysis.

Data Collection and Pre-Screening

PPRC worksheets were mailed to the OEMS in Richmond for the months of April and November 1996 and January 1997. Chuck Kmet, OEMS project coordinator, screened each PPRC form for completeness and highlighted information to be collected. Mr. Kmet worked with VHI personnel to identify the exact data elements to be collected and the edits the system would apply. To improve data entry accuracy, the OEMS project coordinator abstracted key information in a central section of the PPRC form.

Experienced data entry personnel entered all data. Background on the project and the importance of accurate information was stressed and no minimum requirements for keypunch strokes per hour were specified. Records with incomplete information were identified, set aside, and reviewed with the OEMS project coordinator.

VHI randomly sampled forms to identify data entry keypunch errors. While it is not uncommon to identify a 2% data entry error rate, the sample revealed less than one tenth of a percent of data entered contained errors. It was concluded that the database accurately reflected the information provided to VHI.

Preliminary Analysis of Data

The team designed a series of preliminary reports to review aggregate information collected. Examples included distributions of the age, sex, and race of individuals in the study. Ranges of values in key fields such as procedures performed, EKG Rhythm, and epinephrine dosages were evaluated. These findings were presented to the OEMS coordinator and determined to be reasonable. Information was generally complete. The data element, *time call received*, which is the time an agency received the call, had a significant number of missing values. Follow-up analysis found that the missing time values were limited primarily to three agencies. Contact with these three agencies revealed that they used computer-directed dispatching and that the *time call received* was to be considered the same as the time noted that the unit was en route. Based on directions from the OEMS project coordinator, the "*time unit en route*" was used in place of the "*time call received*" for those agencies when calculating intervals.

The "Utstein Style" of Uniform Reporting of Cardiac Arrest

In 1990 international experts began the development of consensus on nomenclature used in reporting resuscitation efforts for cardiac arrest cases. The first meeting was held at the historic Utstein abbey on a small island near Stavanger, Norway. After a series of meetings, consensus on the definition of terms and a style of reporting was reached.

VHI was asked to develop reports in the Utstein Style. VHI formatted data according to Utstein templates provided by OEMS using information on the services provided prior to hospitalization as specified by OEMS. These reports are found in Appendix C.

VHI suggests that a follow-up study with a statistically valid sample could be linked with inpatient hospital data maintained by VHI. The linked data sets would add additional information on the outcomes of hospital care and complete the reporting of data in the Utstein style. This issue is further discussed in the summary section of this report.

Analysis of Data

Introduction

The analysis presented here is based on data from a selected sample of PPCR forms for emergency cardiac arrest patients in Virginia during three months in 1996 and 1997. The procedure used to assemble these data is described elsewhere. These preliminary remarks are intended to note some of the issues and constraints that affect the examination of these data in the following sections of this report.

As originally assembled, the sample data included 519 cases of out-of-hospital cardiac arrests recorded by selected Virginia EMS agencies during the time period of interest. Five of these cases have been excluded from the analysis either because they involved cases other than cardiac arrest or because they represented patients whose ages fall below the lower limit set for this study by the OEMS. Thus the analysis is based on a total of 514 cases of cardiac arrest to which selected Virginia EMS agencies responded during the months of April 1996, November 1996, and January 1997 (see Table 1). Some 53 EMS agencies are represented in this sample (see Table 2). Based on information provided by OEMS, these agencies are divided into three groups depending on the professional status of their emergency personnel: agencies using paid professionals, agencies using volunteer personnel, and agencies using a combination of paid professional and volunteer personnel (Table 3).

The specific information available for analysis is summarized in the list of variables presented in Table 4. Not all information was recorded for all cases in the sample, and this missing information affects the analyses that are possible. While interpretation of most variables follows naturally from the PPCR forms from which the sample data were abstracted, brief discussion is necessary in two instances. First, all time intervals displayed in Table 4 are based on the *time at which the emergency call was received* by an EMS agency. In records from three agencies included in this study (all using paid professional personnel), this time point was not recorded. As directed by OEMS, this missing time point has been treated as identical to the *time at which an emergency unit was en route* for these three agencies only. Because this imputation will produce intervals that are not consistent with the intervals defined correctly for other agencies in the study who recorded both of these time points on their pre-hospital patient care record forms, all analyses below for time intervals of interest have been performed twice including and excluding patients from these three EMS agencies. This way any differential effect caused by using the recorded *time an emergency unit was en route* as a proxy for the missing *time the emergency call was received* will become apparent.

Another complication involving the interpretation of the information available for analysis concerns the variable recorded as *dead on arrival*. Although OEMS has verified that this variable is intended only to record instances where cardiac arrest patients were found to have died before emergency medical personnel arrived on the scene, it is evident from the data that EMS agencies included in this study treated this variable more broadly. Specifically, of 127 cases where dead on arrival was reported, the records for 61 of these

cases indicate attempts by EMS personnel to resuscitate the victim. Thus it is clear that this variable should be interpreted to include patients who died at the scene after the arrival of EMS crews. To signify this the more accurate *dead at scene* is used in this report in preference to the inaccurate *dead on arrival.* (See Addendum for more discussion of this variable.)

The sample data as gathered for this study do not lend themselves to standard statistical analysis due to the nonrandom and selective manner in which the data were chosen for inclusion in this study. All formal statistical methodology is based on the use of some appropriate probability model for the mechanism used (or assumed) to have generated the sample data. This is achieved directly when some form of probability (random) sampling is employed in surveys or when randomization is used to assign treatments to experimental units in designed experiments. No random sampling mechanism was used to assemble the present data, so there is no sampling basis to support any statistically-based generalizations beyond the cases and agencies represented in the sample. Just as important, the selection of the EMS records included in the present study—selected months of interest, selected EMS agencies invited to participate, and self-selection of EMS agencies who actually agreed to participate—means that it is highly unlikely (and virtually impossible to verify) that the present sample is representative of any broader population of Virginia EMS agencies or cardiac arrest patients. This in turn means that any differences or other effects discovered in the present sample cannot be generalized to the experience of Virginia EMS agencies not included in the present study during the time period of the present study, to the experience of Virginia EMS agencies included in the present study in months other than those included in the present study, or to any larger population of Virginia EMS agencies or emergency cardiac arrest patients.

Comparisons based on the present sample data can of course be made, and many such comparisons are presented in the following tables and discussion. For the reasons noted above, the reader must recognize that these comparisons—and any tentative conclusions drawn from them—are severely circumscribed by the limitations of the present sample. Moreover, the interpretation of all statistical tests employed in the course of this analysis must be understood to apply only within this limited interpretive context. Two widely-used statistical procedures are used to explore how various classifications of the observed sample differ from what would be expected "by chance" if the appropriate probability model applied and no difference existed among the distributions of interest. Distributions for qualitative variables like *sex of patient* and *attempt to resuscitate* are compared using standard chi-square tests for two-way contingency tables. Distributions for quantitative variables like *age of patient* and the various *time intervals* of interest are examined using the Kruskal-Wallis test and related pair-wise multiple comparison procedures. These statistical procedures require no assumptions about the underlying distributions for the variables of interest, and the Kruskal-Wallis test is far less sensitive to extreme values and erroneous data values than alternative statistical procedures. In both the chi-square and Kruskal-Wallis tests, the asymptotic distribution of the test statistic (assuming no difference among the distributions being compared) is the well-known chi-square probability distribution, and this distribution (with appropriate degrees of freedom) is used to assess the probability of observing the sample result actually obtained (or one

more extreme) based on a simple random sampling model for each distribution of interest. Since, literally speaking, such probability models cannot be justified by any sampling considerations, the results of all statistical comparisons should not be interpreted in the usual manner. A "statistically significant" result (an observed significance level or "p-value" of 0.05 or less) indicates only that the effect observed in the present sample data cannot easily be explained as a "chance outcome" if the appropriate sampling model were supposed to have produced the present sample and if no actual difference exists among the groups being compared. Thus the tests of statistical significance reported here are intended only to serve as an exploratory framework for investigating the present sample data. More sophisticated techniques might be employed in the future to adjust for the effects of other variables when making comparisons of direct interest, but the validity of these methodologies requires additional attention to inconsistencies in the sample data and specification of an adequate probability model that, among other things, reflects the possible linkage among emergency cases "treated" by the same EMS agency and weights each case to properly reflect its "representativeness" in some broader population of interest.

The structure of the present analysis is suggested by the Utstein style for reporting cardiac arrest patient data and the constraints of the present data. Although the goal of the Utstein template is investigation of medical treatment of out-of-hospital emergency cardiac arrests through the adoption of consistent reporting guidelines, in the present analysis it serves mainly as a tool for organizing comparisons based on characteristics of patients encountered by personnel from selected Virginia EMS agencies during the time period of interest and examining the performance of these EMS agencies as measured by various time intervals determined by OEMS to be of interest. The next section of this report considers descriptive characteristics of the emergency cardiac arrest patients and the time interval from call to arrival of EMS personnel on the scene of the attack using all cases in the sample. After this, cases where resuscitation was attempted by EMS personnel are examined with reference to the types of medical intervention undertaken and the time intervals from call to subsequent treatment and transportation time points. Last, specific comparisons requested by OEMS involving the presence of pulse on arrival at destination and the four time intervals from call to arrival on scene, to first defibrillation, to first dose of epinephrine, and to arrival at destination are reanalyzed for cases where resuscitation was attempted and where cardiac arrest was witnessed.

All Cardiac Arrest Patients

In this section data analysis is based on all 514 cardiac arrest patients in the present sample. Comparisons among the three types of EMS agencies—paid professional, volunteer, and combination—are presented for each variable of interest. In all cases the tables summarizing these comparisons also present corresponding information for the entire sample.

In Table 5 the *age* distributions for patients served by the three groups of EMS agencies are presented using standard five-year age groupings. A comparison of these age distributions using a Kruskal-Wallis test based on the ungrouped age data indicates that there is no statistically significant difference in these age distributions (χ^2=1.849, df=2,

p=0.397). This result is consistent with the median ages for the patients served by the three groups: paid professional agencies, 69 years; volunteer agencies, 68 years; and combination agencies, 66 years.

The distributions for the *race* of the patients served by the three types of agencies are summarized in Table 6. A comparison of these distributions using the chi-square test for this two-way classification indicates that the differences in the races of the patients served by the three agency groups displayed in Table 6 are statistically significant (χ^2=66.338, df=6, p<0.001). The explanation for this result lies in the fact that, compared to the other two groups, patients served by volunteer EMS agencies were comprised of a smaller percentage of Blacks and higher percentages of Whites and Unknowns.

The distributions for *sex* of the cardiac arrest patients treated by the three types of agencies are displayed in Table 7. A comparison of these distributions using the chi-square test for this two-way classification indicates that no statistically significant differences exist (χ^2=4.104, df=4, p=0.392). For all agency types, approximately 40 percent of all cardiac arrest patients during the time period of interest were female and 60 percent were male.

The *first response unit* distributions are presented in Table 8 for the three types of EMS agencies. Comparison of these distributions using a chi-square test for this two-way classification indicates that statistically significant differences among these groups of agencies exist for this variable (χ^2=18.117, df=6, p=0.006). Compared to the paid professional and combination agencies, the volunteer agencies were more frequently the first unit on the scene (52 percent versus 33 percent and 38 percent). The fact that in approximately 40 percent of all cases (for all groups) whether the EMS unit was the first on the scene of the cardiac arrest is unknown or not available suggests that the apparent difference between the volunteer and other agencies could be dramatically affected if more complete information becomes available.

Whether EMS personnel made an *attempt to resuscitate* the cardiac arrest patient is presented in Table 9 for the three types of agencies. Formal comparison of the distributions for this variable is based on the chi-square test for this two-way classification; the result of this test is not statistically significant (χ^2=3.303, df=2, p=0.192). Thus the observed differences for the three types of agencies in the percentages of cases where resuscitation was attempted—83 percent for patients treated by paid professional EMS agencies, 87 percent for those treated by volunteer agencies, and 91 percent by agencies combining professional and volunteer personnel—do not differ from what would be expected if simple random sampling generated the observed sample data summarized in Table 9 from patient populations with identical rates of attempted resuscitation with differences in the observed rates due to only random variation.

The distributions for *witnessed cardiac arrest* for the three types of EMS agencies are shown in Table 10. The chi-square test based on this two-way classification indicates that the differences among these distributions are statistically significant (χ^2=23.271,

df=6, p=0.001). Inspection of these distributions demonstrates that, compared to the other two groups, the paid professional agencies more often encountered unwitnessed cardiac arrests and less frequently recorded unknown as the response to this question on the PPCR forms. Since the higher percentages of unknown responses to this question for the volunteer and combination EMS agency groups may explain this discrepancy, it is hard to attach much importance to this result.

The frequency in which cardiac arrest patients were *dead at the scene* of their attacks is presented in Table 11 for the three types of EMS agencies. The difference observed in this table between the 14 percent of patients who died at the scene encountered by combination agencies and the corresponding 27 percent for the professional and volunteer agencies is statistically significant based on the chi-square test for this two-way classification (χ^2=7.291, df=2, p=0.026). The reader will recall that *dead at scene* includes patients dead when EMS personnel arrived as well as some cases where patients died after resuscitation was attempted. Thus the apparent difference here may simply reflect inconsistent reporting by the various EMS agencies included in this study rather than a real discrepancy in rates of death at the scene of cardiac arrests.

Let us conclude this section of the analysis by examining the *time interval (in minutes) from receiving the emergency call to arrival of the EMS unit on the scene of the cardiac arrest* (see Table 12). Inspection of the summary descriptive statistics for the paid professional agencies and for all agencies combined when the three agencies where the *time the unit was en route* was used as a proxy for the missing *time the emergency call was received* are included and excluded suggests that this imputation has a noticeable effect on the distributions for this time interval. For example, the median time interval is five minutes for professional agencies when these three agencies are included but six minutes when they are excluded. A formal comparison of the distributions for the time-to-arrival interval for the three types of EMS agencies including the three agencies using the Kruskal-Wallis test indicates that there are statistically significant differences among these distributions (χ^2=68.504, df=2, p<0.001). Using a conservative procedure designed to control the "experiment-wise" error rate to compare pairs of distributions indicates that there is no statistically significant difference with respect to the distributions of time to arrival at the scene between the paid professional and combined EMS agencies, but that both are significantly different from the volunteer EMS agencies. This result is illustrated by the medians for this time interval reported in Table 12 for the three groups: the median time interval for volunteer agencies was nine minutes, compared to five minutes for the professional agencies and four minutes for the combination agencies. The results of the Kruskal-Wallis test (χ^2=36.406, df=2, p<0.001) and paired comparisons are unchanged if the three professional agencies with missing *times calls were received* replaced with *times units were en route* are excluded from the analysis.

Cardiac Arrest Patients Where Resuscitation was Attempted

In this section of the analysis only the 440 patients in the sample whom EMS personnel attempted to resuscitate are considered. As instructed by OEMS, *attempted to resuscitate* means that at least one of the following five procedures was employed by EMS personnel: *automated external defibrillation (AED), cardiopulmonary resuscitation*

(CPR), incubation, chest decompression, or *defibrillation-cardioversion*. Here the focus of our investigation is the type of treatments these patients received from EMS crews and the performance of the EMS personnel as measured by the time intervals from the time the emergency call was received to two treatment time points and to the time the patients transported by EMS crews ultimately arrived at their destinations. Recall that in the previous section of this analysis, no statistically significant difference was detected in the rate EMS personnel from the three types of agencies attempted to resuscitate cardiac arrest patients.

Whether EMS personnel used AED in their resuscitation attempts is presented for the three agency types in Table 13. Comparison of these distributions using the chi-square test for this two-way classification indicates that the observed sample outcomes are statistically significant (χ^2=21.295, df=2, p<0.001). Compared to the volunteer and combination agencies, the paid professional EMS agencies more often employed *AED*: 91 percent versus 74 percent for the volunteer agencies and 77 percent for the combination agencies.

Whether EMS personnel used CPR in their resuscitation attempts is presented for the three agency types in Table 14. Comparison of these distributions using the chi-square test for this two-way classification indicates that the observed differences in the sample are not statistically significant (χ^2=1.391, df=2, p=0.499). In approximately 94 percent of all cases where resuscitation was attempted, EMS personnel used CPR regardless of the type of agency.

Whether EMS personnel used *incubation* in their resuscitation attempts is presented for the three agency types in Table 15. Comparison of these distributions using the chi-square test for this two-way classification indicates that the observed differences in the sample are not statistically significant (χ^2=5.255, df=2, p=0.072). In approximately 90 percent of all cases where resuscitation was attempted, EMS personnel used *incubation* regardless of the type of agency.

Whether EMS personnel used *chest decompression* in their resuscitation attempts is presented for the three agency types in Table 16. Comparison of these distributions using the chi-square test for this two-way classification indicates that the differences observed in the sample are not statistically significant (χ^2=1.156, df=2, p=0.561). In approximately only one percent of all cases where resuscitation was attempted, EMS personnel used *chest decompression* regardless of the type of agency.

Whether EMS personnel used *defibrillation-cardioversion* in their resuscitation attempts is presented for the three agency types in Table 17. Comparison of these distributions using the chi-square test for this two-way classification indicates that the observed differences in the sample for this variable are not statistically significant (χ^2=3.335, df=2, p=0.189). In approximately 49 percent of all cases where resuscitation was attempted, EMS personnel used *defibrillation-cardioversion* regardless of the type of agency.

Now let us consider other medical interventions performed by EMS personnel in their treatment of cardiac arrest patients. Whether EMS personnel used *EKG monitoring* is presented for the three agency types in Table 18. Comparison of these distributions using the chi-square test for this two-way classification indicates that the differences observed in the sample for this variable are not statistically significant (χ^2=2.578, df=2, p=0.276). In approximately 78 percent of all cases where resuscitation was attempted, EMS personnel used *EKG monitoring* regardless of the type of agency. (However, note that an *EKG rhythm observed* is reported for all 440 cases; see below.)

Whether EMS personnel used *epinephrine* in their treatment of cardiac arrest patients is presented for the three types of EMS agencies in Table 19. Comparison of these distributions using the chi-square test for this two-way classification indicates that any differences observed for this variable in the sample are not statistically significant (χ^2=5.720, df=2, p=0.057). In approximately 87 percent of all cases where resuscitation was attempted, EMS personnel used *epinephrine* regardless of the type of agency.

The distributions for *EKG rhythm observed* for the 440 patients for whom resuscitation was attempted are displayed in Table 20 for the three types of EMS agencies. Formal comparison of these distributions using a chi-square test for this two-way classification indicates that the differences in EKG rhythm observed in the sample are not statistically significant. (For the purposes of this test the observed rhythms were collapsed into three categories—ventricular fibrillation, asystole, and all others—to produce the following results: χ^2=6.216, df=4, p=0.184). Regardless of type of EMS agency, approximately 39 percent of cardiac arrest patients exhibited ventricular fibrillation, 42 percent exhibited asystole, and the remainder exhibited some other type of rhythm.

Information related to other variables describing the condition of the patient or actions taken by EMS personnel can also be compared in this investigation. For a start, let us examine whether *bystander CPR* was performed (presumably before the arrival of an EMS unit at the scene) on the patients whom EMS personnel attempted to resuscitate. Table 21 presents the distributions of responses recorded on the PPCR forms for this variable for the 440 patients whom EMS personnel attempted to resuscitate. A formal comparison using the chi-square test for this two-way classification indicates that the differences among the three groups apparent in this table are statistically significant (χ^2=40.591, df=2, p<0.001). Evidently the patients treated by paid professional EMS agencies less frequently were given CPR by bystanders but were more often given CPR by another health care provider. Patients handled by volunteer and combination agencies were more often given CPR by bystanders. Also apparent in Table 21 is the relatively higher percentage of cases treated by volunteer agencies where whether bystander CPR had been performed was unknown compared to the other two types of agencies. This fact almost certainly affects the comparison among the three types of agencies for this variable.

Whether the rates for patients *dead at the scene* of the cardiac arrest differed among the three groups of agencies has already been examined for all patients in the sample. Because of the ambiguity in how this variable was interpreted, it is reasonable to consider

it again—this time for only the patients for whom resuscitation was attempted. Table 22 presents the distributions for *dead at the scene* for these patients classified by the three types of EMS agencies. Although it appears that in the sample a higher percentage of patients for whom resuscitation was attempted were dead at the scene for the combination agencies compared to the paid and volunteer agencies, a comparison of these distributions using the chi-square test for this two-way classification indicates that no statistically significant difference exists among the three groups with respect to this variable (χ^2=4.634, df=2, p=0.099).

Whether the *cardiac arrests were witnessed* for the patients EMS personnel attempted to resuscitate is presented in Table 23 for the three types of agencies. Comparing these distributions using the chi-square test for this two-way classification indicates that the distributions for this variable differ in a statistically significant fashion (χ^2=16.303, df=6, p=0.012). Inspecting this table, it appears that in approximately one-third of all cases where resuscitation was attempted, the cardiac arrests were witnessed by bystanders with differences among the three types of agencies in the other response classifications for this variable.

Whether EMS personnel *transported* the patients they attempted to resuscitate is presented in Table 24 for the three types of EMS agencies. Comparison of these distributions using the chi-square test for this two-way classification indicates that the observed differences for this variable in the sample are not statistically significant (χ^2=1.445, df=2, p=0.485). Approximately 85 percent of patients for whom resuscitation was attempted were transported by EMS personnel regardless of the type of agency.

The *type of life support* given in cases where resuscitation was attempted is shown for the three groups of EMS agencies in Table 25. One can see that volunteer agencies more frequently (although only approximately five percent of the time) used basic life support compared to the other two types of EMS agencies while EMS personnel from the paid professional agencies more often (although only approximately 8 percent of the time) used no life support. A formal comparison of these distributions using the chi-square test for this two-way classification indicates that the differences observed in the sample are statistically significant (χ^2=10.006, df=2, p=0.040).

Let us conclude our examination of the distributions of the qualitative variables in this section of the analysis with whether there was a *pulse on arrival at the destination* for the patients for whom resuscitation was attempted. The distributions for this variable for the three types of agencies are presented in Table 26. Formal comparison of these distributions using the chi-square test for this two-way classification indicates that no statistically significant difference exists for this variable (χ^2=1.065, df=2, p=0.587). Regardless of type of agency, approximately 21 percent of all patients who EMS personnel attempted to resuscitate exhibited a *pulse on arrival* at their destinations.

The sample data provide three time intervals identified by OEMS for which all cardiac arrest patients for whom resuscitation was attempted seems to be the relevant group. Here these intervals (all measured in minutes) are examined in the following order:

interval from time of call to time of first defibrillation, interval from time of call to first dose of epinephrine, and *interval from time of call to arrival at destination*. Not all time points were recorded for all cases, so the numbers of cases involved in each comparison will vary to reflect this missing information. As noted above, for three professional agencies OEMS indicated that the recorded *time the unit was en route* should be used as a proxy for the unrecorded *time the emergency call was received*. The analyses discussed here will, as before, deal with this imputation by performing all formal comparisons twice, including and excluding the cases represented by the three agencies for which the missing time of call was treated in the manner described.

Summary information for the distributions for the *interval from time of call to first defibrillation* is presented in Table 27 for the three types of EMS agencies. A comparison of these distributions using the Kruskal-Wallis test procedure indicates that statistically significant differences exist among the three agency groups with respect to this time interval (χ^2=14.973, df=2, p=0.001). Paired comparisons among the three agency types using a conservative procedure designed to control the "experiment-wise" error rate indicate that the statistically significant difference detected by the Kruskal-Wallis test is between the distributions for this time interval for the volunteer and combination agencies. As Table 27 indicates, these two groups of EMS providers exhibited comparable variability for this time interval, but compared to the combination agencies, the volunteer agencies demonstrated a higher median *interval from time of call to first defibrillation*: 9 minutes versus 6.5 minutes. This result is not materially affected if the three paid professional agencies with *time the unit was en route* treated as the *time of call* are excluded from the analysis (χ^2=15.915, df=2, p<0.001); although, in this instance the paired comparisons between distributions indicate that the differences between paid and volunteer and between combination and volunteer agencies are both statistically significant.

The distributions for the *interval from receipt of the emergency call to first dose of epinephrine* also appear to differ among the three agency types (see Table 28). Comparison of these distributions using the Kruskal-Wallis test produces a statistically significant result (χ^2=23.581, df=2, p<0.001). In this instance the result is explained by the differences between the paid professional and volunteer EMS agencies and between the combination and volunteer EMS agencies as indicated by paired comparisons among the three sample distributions. Note that the median *interval from call to first dose of epinephrine* is 16 minutes for the professional agencies, 14 minutes for the combination agencies, and 20 minutes for the volunteer agencies. The results of the Kruskal-Wallis test (χ^2=22.949, df=2, p<0.001) and the paired comparisons still hold when the three professional agencies with the missing time of call received are excluded from the analysis.

Finally the distributions for the *interval from time of emergency call to arrival of the transported patient at his or her destination* are summarized for the three types of EMS agencies in Table 29. Formally comparing these distributions using the Kruskal-Wallis test indicates that statistically significant differences exist among the agency types for this time interval (χ^2=39.319, df=2, p<0.001). Using the conservative paired comparison

procedure, it is possible to determine that statistically significant differences exist between each type of agency and the others. This result is illustrated by the median *interval to arrival at destination* for the three groups: 49 minutes for the professional agencies, 74 minutes for the combination agencies, and 82 minutes for the volunteer agencies. When this analysis is repeated excluding the three professional agencies with missing times for calls received, the results are somewhat different. The Kruskal-Wallis test still produces a result indicating statistical significance (χ^2=9.008, df=2, p=0.011), but now the paired comparison between the paid professional and combination agencies is no longer statistically significant. In this analysis based on the reduced sample, it is still evident that the distributions for the interval to arrival at destination for paid and combination agencies differ from the corresponding distribution for the volunteer agencies. This is illustrated by reference to the sample medians: the median interval from call to destination for the reduced professional group is 76 minutes which does not differ appreciably from the median of 74 minutes for the combination agencies. On the other hand, both of these values are exceeded by the median for the volunteer agencies of 82 minutes.

Additional Analysis Requested by OEMS

In this section specific issues raised by OEMS are addressed. The additional analyses summarized here relate to two topics. First, the possible relationship of the variable *pulse on arrival at destination* to *witnessed cardiac arrest*, *bystander CPR*, and *first response unit* is examined. Second, the four time intervals are analyzed again, but here for only cases in the sample with witnessed cardiac arrest where resuscitation was attempted. As before, missing information from individual patient records will cause the number of cases included in each of these latter comparisons to fluctuate.

As reported in the previous section, in general one-third of 440 cardiac arrest patients in the sample for whom resuscitation was attempted exhibited a *pulse on arrival at destination* regardless of the type of EMS agency. Table 30 displays whether these same patients exhibited a *pulse on arrival at destination* according to the four classifications of *witnessed cardiac arrest*. The chi-square test for this two-way classification is statistically significant (χ^2=18.108, df=3, p<0.001). Inspection of the table indicates that approximately 29 percent of patients with cardiac arrest witnessed by either bystanders or health care providers exhibited a pulse on arrival at destination with smaller corresponding percentages when cardiac arrest was not witnessed or unknown.

On the other hand, Table 31 suggests that whether a patient for whom resuscitation was attempted exhibited a *pulse on arrival at destination* did not depend on whether the patient received *bystander CPR*. A chi-square test based on the two-way classification shown in Table 31 does not produce a statistically significant result (χ^2=4.274, df=3, p=0.233). Nor, as Table 32 demonstrates, does presence or absence of a *pulse on arrival at destination* appear to depend on whether EMS personnel were the *first response unit* on the scene since the chi-square test based on this two-way classification also fails to attain statistical significance (χ^2=5.233, df=3, p=0.155).

At the request of OEMS we now re-examine the distributions of the time intervals from the time of call to arrival on scene, first defibrillation, first dose of epinephrine, arrival at destination for only the cases where resuscitation was attempted, and with cardiac arrests witnessed by bystanders. Table 33 presents summaries for the distributions for the *time interval from receiving the emergency call to arrival of the EMS unit on the scene* for this reduced subset of the sample data. As before, the Kruskal-Wallis test is used to make formal comparisons among these distributions. Including the three professional agencies with imputed times for call received, the Kruskal-Wallis test indicates that there are statistically significant differences among the three groups of EMS agencies (χ^2=32.944, df=2, p<0.001). Paired comparisons among the three groups indicate that the differences between the paid professional and volunteer and between the combination and volunteer agencies are statistically significant. These results are not altered when the Kruskal-Wallis test is based on the sample excluding the three professional agencies with imputed times for call received (χ^2=20,758, df=2, p<0.001).

The distributions for the *time interval from call to first defibrillation* for the cases where resuscitation was attempted with witnessed cardiac arrests are summarized in Table 34. Comparison of these distributions based on all available cases using the Kruskal-Wallis test produces a statistically significant result (χ^2=6.147, df=2, p=0.046). Paired comparisons indicate that the statistically significant difference in the *time interval from call to first defibrillation* is that between the volunteer and combination agencies. Repeating the Kruskal-Wallis test for the reduced sample excluding the three professional agencies with imputed times of call received again indicates the presence of a statistically significant difference among the three types of agencies for this variable (χ^2=6.650, df=2, p=0.036), and the paired comparisons procedure again indicates that this difference is between the volunteer and combination EMS agencies.

The distributions for the *time interval from call to first dose of epinephrine* for the cases where resuscitation was attempted with witnessed cardiac arrest are summarized in Table 35. Comparing these distributions using the Kruskal-Wallis test produces a statistically significant result (χ^2=11.468, df=2, p=0.003). Here the statistically significant difference is determined to be that between the distributions for the paid professional and volunteer agencies. The same result is obtained when the Kruskal-Wallis test is based on the sample data from which the three professional agencies with imputed times calls were received have been excluded (χ^2=8.871, df=2, p=0.012) with the same difference between the professional and volunteer agencies determined to be the only statistically significant paired comparison.

Descriptive statistics for the distributions for the *time interval from call to arrival at destination* for the cases where resuscitation was attempted and where cardiac arrest was witnessed are presented in Table 36. Using all available data, the comparison of these three distributions using the Kruskal-Wallis test indicates the existence of at least one statistically significant difference among the three groups with respect to this interval (χ^2=20.779, df=2, p<0.001). Using the paired comparison procedure, the only statistically significant difference between groups of agencies is between the paid professional and volunteer EMS agencies. However when the Kruskal-Wallis test is

repeated excluding the three professional agencies with imputed times calls were received, the result is not statistically significant (χ^2=4.185, df=2, p=0.123) indicating that when the professional agencies with imputed times are excluded none of the differences among the distributions for the *interval from call to arrival at destination* apparent in Table 36 are statistically significant.

Discussion

Given the constraints governing the analysis of this sample data, the results obtained in the exploratory investigation described above cannot be stated with great confidence. In the analysis of the 514 cardiac arrest patients, it appears that the racial composition of the patients treated by the volunteer EMS agencies in the sample differed from those served by paid professional and combination EMS agencies. Apparent differences between types of agencies for *first response unit* and *witnessed cardiac arrest* are difficult to interpret given the relatively high percentages of cases where the response was "unknown". The importance of the difference observed between combination agencies on one hand and volunteer or paid professional agencies on the other in terms of patients who died at the scene is unclear given the ambiguity in how the variable *dead on arrival/dead at scene* was actually recorded by EMS personnel on the PPCR forms. There is evidence that the *time interval from call to arrival at scene* tended to be shorter for paid professional and combination agencies, but this outcome may be explained by the geographic distribution of EMS agencies in Virginia or other factors not considered here.

Based on the analysis of the 440 cases in the sample where EMS personnel attempted resuscitation, some differences in treatment procedures performed do arise, but whether these differences have genuine clinical significance is, of course, not a statistical issue. Once again, responses of "unknown" complicate the differences observed among the three agency types for the variables *bystander CPR* and *witnessed cardiac arrest.* Analysis of the time intervals for this subgroup of the sample confirms the general pattern observed earlier for the interval from call to arrival on scene. Because the first interval is necessarily contained in all subsequent intervals, this result is hardly surprising. In terms of the time intervals from call to first defibrillation, from call to first dose of epinephrine, and from call to arrival at destination, the volunteer EMS agencies tended to require more time to perform the tasks of interest. As noted above, geographic or other factors may explain the differences observed in this sample.

Regarding the examination of questions related to *pulse on arrival at destination* for patients for whom resuscitation was attempted, it appears that patients who suffered witnessed cardiac arrests were more likely to exhibit a pulse on arrival at destination, but no relationship is indicated between *pulse on arrival* and either *bystander CPR* and *first response unit.* The re-analysis of the time interval data for patients who suffered witnessed cardiac arrests and for whom resuscitation was attempted suggests, as before, that volunteer EMS agencies tended to require more time to perform the tasks of interest compared to one or the other the two other agency types, although the inclusion of the three professional agencies with imputed times for when calls were received can affect these observations.

Prospects for further analysis are based on first, improving the quality and consistency of the information in the present sample and any information collected in the future using the PPCR forms, and second, supplementing the information currently available with data related to the actual time of cardiac arrest and patient outcomes after transportation by EMS personnel. Statistical analysis using more complex techniques—adjusting comparisons for the effects of other variables, for example—will require refinement of the sample data and development of a suitable probability model.

Addendum

To supplement the discussion in the text concerning the apparent inconsistent interpretation of the variable *dead on arrival/dead at scene* by EMS personnel in the PPCR forms upon which this investigation is based, Table 1 in Appendix B categorizes the 127 cases where *dead on arrival at scene* is indicated by whether resuscitation was attempted and the various EMS agencies reporting such cases. The fact that for many agencies we find all dead on arrival cases in one column or the other of this table confirms the inconsistency among agencies for recording the *dead on arrival* variable.

Conclusion

The success of the OEMS in collecting PPCR forms from EMS agencies for a specific condition clearly indicates that other studies are feasible. The level of completeness of PPCR forms was high and gives confidence that other studies can be supported with this data. VHI recommends that consideration be given to conducting educational programs that would stress the importance of accurate and complete data as well as the standardization of data collection. Examples where data quality may be improved include patient identifiers (social security number), certain time intervals for agency responses, and the definition of information categorized as "*Dead On Arrival*".

Data analysis indicates that there are areas where comparisons of certain treatment regimens vary by type of agency. While these results cannot be generalized to all agencies, it is clear that with a more comprehensive and representative sample, important and statistically significant information can be derived from PPCR forms to assist EMS agencies and the OEMS in providing the best care possible.

Finally, VHI believes that additional studies can provide valuable insights into the effectiveness of treatment regimens if PPCR forms are merged with hospital data to produce detailed information using the internationally developed Utstein Model. These data are available and are recognized as an important link in developing comprehensive information on care provided to cardiac arrest patients.

Appendix A

Tables 1 through 4	Background Reports
Tables 5 through 12	Overall Reports
Tables 13 through 32	Resuscitation Attempted Reports
Tables 33 through 36	Resuscitation Attempted and Witnessed Cardiac Arrest Reports

Tables 1 through 4

Background Reports

Table 1 - Frequency of Month of Event

Month of Event

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	April	135	26.3	26.3	26.3
	January	219	42.6	42.6	68.9
	November	157	30.5	30.5	99.4
	September	1	.2	.2	99.6
	Unknown	2	.4	.4	100.0
	Total	514	100.0	100.0	
Total		514	100.0		

Table 2 - EMS Agency by Council

				Count	Col %
Region/Council	Blue Ridge	Agency	Appomattox Volunteer	1	.2%
		Group Total		1	.2%
	Northern Virginia	Agency	Arlington County EMS	6	1.2%
			Prince William County EMS	16	3.1%
			Loudoun County Volunteer	2	.4%
		Group Total		24	4.7%
	Old Dominion EMS	Agency	Manchester Volunteer	6	1.2%
			Bensley-Bermuda Volunteer	1	.2%
			Southside Virginia Emergency Crew	17	3.3%
			Colonial Heights Fire/EMS	6	1.2%
			Chesterfield Fire	16	3.1%
			Richmond Ambulance	61	11.9%
			Goochland County Fire	5	1.0%
		Group Total		112	21.8%
	Peninsula EMS	Agency	Tappahannock Volunteer	1	.2%
			Abingdon Volunteer	3	.6%
			Mathews Volunteer	6	1.2%
			York County Fire & Rescue	6	1.2%
			James City County	20	3.9%
			Newport News Fire Dept	43	8.4%
			Buckroe Beach Volunteer	3	.6%
			Hampton Division	38	7.4%
		Group Total		120	23.3%
	Southwest Virginia	Agency	Norton Rescue Squad	2	.4%
			Dante Rescue Squad	1	.2%
			Bluefield Va. Rescue Squad	1	.2%
			Washington County	5	1.0%
			Glade Spring Volunteer	1	.2%
			Lee County Rescue Squad	1	.2%
		Group Total		11	2.1%

				Count	Col %
Region/Council	Tidewater EMS	Agency	Cape Charles Rescue Service	3	.6%
			Nansemond-Suffolk Volunteer	10	1.9%
			Norfolk Fire & Paramedical	29	5.6%
			Ocean Park Volunteer	5	1.0%
			Virginia Beach Volunteer	12	2.3%
			Plaza Volunteer	14	2.7%
			Kempsville Volunteer	8	1.6%
			Princess Anne Courthouse	5	1.0%
			Wachapreague Volunteer	1	.2%
			Chesapeake Beach Fire	5	1.0%
			Davis Corner Volunteer	8	1.6%
			Chesapeake Fire Dept	27	5.3%
		Group Total		127	24.7%
	Virginia Federation	Agency	Woodstock Volunteer	4	.8%
			Charlottesville-Albemarle EMS	25	4.9%
			Lake Monticelo Volunteer	2	.4%
			Bridgewater Volunteer	9	1.8%
			Middletown Volunteer	2	.4%
			Fredericksburg Rescue Squad	6	1.2%
			Stuarts Draft Rescue Squad	2	.4%
			Spotsylvania County	7	1.4%
			Trevilians Volunteer	1	.2%
		Group Total		58	11.3%
	Western Virginia	Agency	Roanoke Fire-EMS Dept	17	3.3%
			Clearbrook First Aid	1	.2%
			Danville Life Saving	11	2.1%
			Roanoke County Fire	8	1.6%
			Roanoke Emergency	15	2.9%
			Henry County	5	1.0%
			Regional EMS	4	.8%
		Group Total		61	11.9%
Table Total				514	100.0%

Table 3 - Agency by Professional Status

				Count	Col %
Professional Status	Paid	Agency	Arlington County EMS	6	1.2%
			Prince William County EMS	16	3.1%
			Bensley-Bermuda Volunteer	1	.2%
			Norfolk Fire & Paramedical	29	5.6%
			York County Fire & Rescue	6	1.2%
			James City County	20	3.9%
			Newport News Fire Dept	43	8.4%
			Buckroe Beach Volunteer	3	.6%
			Hampton Division	38	7.4%
			Chesapeake Fire Dept	27	5.3%
			Colonial Heights Fire/EMS	6	1.2%
			Chesterfield Fire	16	3.1%
			Richmond Ambulance	61	11.9%
			Henry County	5	1.0%
		Group Total		277	53.9%

				Count	Col %
Professional Status	Volunteer	Agency	Norton Rescue Squad	2	.4%
			Dante Rescue Squad	1	.2%
			Bluefield Va. Rescue Squad	1	.2%
			Woodstock Volunteer	4	.8%
			Charlottesville-Albemarle EMS	25	4.9%
			Lake Monticelo Volunteer	2	.4%
			Appomattox Volunteer	1	.2%
			Manchester Volunteer	6	1.2%
			Washington County	5	1.0%
			Bridgewater Volunteer	9	1.8%
			Middletown Volunteer	2	.4%
			Glade Spring Volunteer	1	.2%
			Tappahannock Volunteer	1	.2%
			Abingdon Volunteer	3	.6%
			Mathews Volunteer	6	1.2%
			Ocean Park Volunteer	5	1.0%
			Virginia Beach Volunteer	12	2.3%
			Plaza Volunteer	14	2.7%
			Kempsville Volunteer	8	1.6%
			Princess Anne Courthouse	5	1.0%
			Wachapreague Volunteer	1	.2%
			Chesapeake Beach Fire	5	1.0%
			Stuarts Draft Rescue Squad	2	.4%
			Loudoun County Volunteer	2	.4%
			Danville Life Saving	11	2.1%
			Davis Corner Volunteer	8	1.6%
			Trevilians Volunteer	1	.2%
			Goochland County Fire	5	1.0%
		Group Total		148	28.8%
	Combination	Agency	Roanoke Fire-EMS Dept	17	3.3%
			Clearbrook First Aid	1	.2%
			Cape Charles Rescue Service	3	.6%
			Fredericksburg Rescue Squad	6	1.2%
			Southside Virginia Emergency Crew	17	3.3%
			Nansemond-Suffolk Volunteer	10	1.9%
			Lee County Rescue Squad	1	.2%
			Roanoke County Fire	8	1.6%
			Roanoke Emergency	15	2.9%
			Spotsylvania County	7	1.4%
			Regional EMS	4	.8%
		Group Total		89	17.3%
Table Total				514	100.0%

Table 4 - EMS Data Elements

I. The following variables are abstracted from Pre-Hospital Patient Care Report forms

Field	Description	Type	Values
Agency	The name of individual EMS agencies	Required	N/A
Age	Age of the patient (broken down into 5 year intervals)	Required	Age in years
Race	Recorded race of cardiac arrest patients	Required	White, Black, Hispanic, Asian, Unknown
Sex	Recorded sex of cardiac arrest patients	Required	Male, Female, Unknown
Time Call Received	Time the EMS agency received the emergency call	Required	Military time
Time Unit En Route	Time the EMS personnel were mobilized	Required	Military time
Time Arrive Scene	Time the EMS personnel arrived at the scene of the emergency	Required	Military time
Time Arrive Destination	Time the EMS personnel arrived at the hospital	Required	Military time
AED (Automated External Defibrillation)	One of the 6 OEMS selected procedures		Yes, No
Chest Decompression	One of the 6 OEMS selected procedures		Yes, No
CPR (Cardio Pulmonary Resuscitation)	One of the 6 OEMS selected procedures		Yes, No
Defib-Cardioversion	One of the 6 OEMS selected procedures		Yes, No
Endo Tube (Incubation)	One of the 6 OEMS selected procedures		Yes, No
EKG monitor	One of the 6 OEMS selected procedures		Yes, No
Transport	Indicates whether or not a patient was transported to a hospital	Not Required	Yes, No
ALS (Advanced Life Support)	Indicates whether or not a patient received advanced life support	Required	Yes, No
BLS (Basic Life Support)	Indicates whether or not a patient received basic life support	Required	Yes, No
Pulse	Indicates whether or not a patient had a pulse upon arrived at the destination		Yes, No
DOA	Indicates if a patient died at the scene		Yes, No
EKG Rhythm	The recorded patient EKG Rhythm	Required	See attached list
Time of First Defibrillation	Time the EMS personnel administered the first defibrillation	Required	Military time
Epinephrine	Indicates whether or not a patient was administered epinephrine	Required	Yes, No
Time of First Epinephrine Dose	Time the EMS personnel administered the first epinephrine dose	Required if epinephrine given	Military time
Witnessed Cardiac Arrest	Indicates whether or not the cardiac arrest was witnessed and if so, by whom	Required	Yes, No, Unknown, By Health Care Provider
Bystander CPR	Indicates whether or not a patient received CPR from a bystander	Required	Yes, No, Unknown
First Response Units	Whether or not the EMS personnel were the first emergency units to respond at the scene	Required	Yes, No, Unknown, N/A

List of EKG Rhythms:
Normal Sinus, Sinus Tachycardia, Sinus Bradycardia, Premature Atrial Contractions, Atrial Tachycardia, Atrial Flutter, Atrial Fibrillation, Premature Ventricular Contractions, Ventricular Tachycardia, Ventricular Fibrillation, Asystole, First Degree Heart Block, Second Degree Heart Block, Type I, Second Degree Heart Block, Type II, Third Degree Heart Block, Pacemaker Rhythm, Idioventricular Rhythm, Junctional Rhythm, Pulseless Electrical Activity, Unknown

Tables 5 through 12

Overall Reports

Table 5 - Age Group by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Age Group	15 to 19	2	.7%					2	.4%
	20 to 24	4	1.4%	1	.7%	2	2.3%	7	1.4%
	25 to 29	2	.7%			2	2.3%	4	.8%
	30 to 34	7	2.5%	4	2.7%	1	1.1%	12	2.3%
	35 to 39	6	2.2%	7	4.7%	1	1.1%	14	2.7%
	40 to 44	9	3.3%	6	4.1%			15	2.9%
	45 to 49	12	4.3%	9	6.1%	8	9.1%	29	5.7%
	50 to 54	17	6.2%	11	7.4%	8	9.1%	36	7.0%
	55 to 59	17	6.2%	8	5.4%	3	3.4%	28	5.5%
	60 to 64	25	9.1%	16	10.8%	12	13.6%	53	10.4%
	65 to 69	38	13.8%	19	12.8%	12	13.6%	69	13.5%
	70 to 74	32	11.6%	18	12.2%	14	15.9%	64	12.5%
	75 to 79	39	14.1%	23	15.5%	8	9.1%	70	13.7%
	80 to 84	35	12.7%	14	9.5%	4	4.5%	53	10.4%
	85 to 89	20	7.2%	7	4.7%	8	9.1%	35	6.8%
	90 to 94	8	2.9%	2	1.4%	3	3.4%	13	2.5%
	95 to 99	1	.4%	3	2.0%	2	2.3%	6	1.2%
	100 to 104	2	.7%					2	.4%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 6 - Race by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Race	Black	126	45.5%	28	18.9%	36	40.4%	190	37.0%
	White	147	53.1%	93	62.8%	51	57.3%	291	56.6%
	Hispanic	1	.4%	2	1.4%			3	.6%
	Unknown	3	1.1%	25	16.9%	2	2.2%	30	5.8%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 7 - Sex by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Sex	Female	118	42.6%	56	37.8%	32	36.0%	206	40.1%
	Male	159	57.4%	91	61.5%	56	62.9%	306	59.5%
	Unknown			1	.7%	1	1.1%	2	.4%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 8 - First Response Units by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
First Response Units	Yes	92	33.2%	77	52.0%	34	38.2%	203	39.5%
	No	85	30.7%	27	18.2%	22	24.7%	134	26.1%
	Unknown	47	17.0%	20	13.5%	20	22.5%	87	16.9%
	N/A	53	19.1%	24	16.2%	13	14.6%	90	17.5%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 9 - Resuscitation Attempt by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Resuscitation Attempted	No	46	16.6%	20	13.5%	8	9.0%	74	14.4%
	Yes	231	83.4%	128	86.5%	81	91.0%	440	85.6%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 10 - Witnessed Cardiac Arrest by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Witnessed Cardiac Arrest	Yes	85	30.7%	45	30.4%	30	33.7%	160	31.1%
	No	110	39.7%	32	21.6%	23	25.8%	165	32.1%
	Unknown	54	19.5%	51	34.5%	29	32.6%	134	26.1%
	By Health Care Provider	28	10.1%	20	13.5%	7	7.9%	55	10.7%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 11 - Dead at Scene by Professional Status

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
DOA	No	202	72.9%	108	73.0%	77	86.5%	387	75.3%
	Yes	75	27.1%	40	27.0%	12	13.5%	127	24.7%
Table Total		277	100.0%	148	100.0%	89	100.0%	514	100.0%

Table 12 - Time Call Received-To-Time Arrive Scene Interval (Minutes)

	All Patients				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	276	143	135	81	492	359
Mean	7.71	10.24	15.91	12.51	10.75	12.89
Standard Deviation	9.56	12.54	17.12	16.93	13.82	15.57
Minimum	0.0	0.0	0.0	1.0	0.0	0.0
Lower Quartile	4.0	4.0	6.0	3.0	4.0	4.0
Median	5.0	6.0	9.0	4.0	6.0	7.0
Upper Quartile	7.0	9.0	15.0	10.0	10.0	12.0
Maximum	51.0	51.0	73.0	62.0	73.0	73.0
Interquartile Range	3.0	5.0	9.0	7.0	6.0	8.0
Range	51.0	51.0	73.0	61.0	73.0	73.0

Tables 13 through 32

Resuscitation Attempted Reports

Table 13 - AED by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
AED	No	211	91.3%	95	74.2%	62	76.5%	368	83.6%
	Yes	20	8.7%	33	25.8%	19	23.5%	72	16.4%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 14 - CPR by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
CPR	No	11	4.8%	10	7.8%	5	6.2%	26	5.9%
	Yes	220	95.2%	118	92.2%	76	93.8%	414	94.1%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 15 - Endo Tube by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Endo Tube	No	20	8.7%	20	15.6%	6	7.4%	46	10.5%
	Yes	211	91.3%	108	84.4%	75	92.6%	394	89.5%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 16 - Chest Decompression by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Chest Decompression	No	228	98.7%	127	99.2%	81	100.0%	436	99.1%
	Yes	3	1.3%	1	.8%			4	.9%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 17 - Defib-Cardioversion by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Defib-Cardioversion	No	123	53.2%	68	53.1%	34	42.0%	225	51.1%
	Yes	108	46.8%	60	46.9%	47	58.0%	215	48.9%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 18 - EKG Monitor by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
EKG	No	50	21.6%	34	26.6%	14	17.3%	98	22.3%
	Yes	181	78.4%	94	73.4%	67	82.7%	342	77.7%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 19 - Epinephrine Given by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Epinephrine Given	No	23	10.0%	20	15.6%	16	19.8%	59	13.4%
	Yes	208	90.0%	108	84.4%	65	80.2%	381	86.6%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 20 - EKG Rhythm by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
EKG Rhythm						2	2.5%	2	.5%
	Normal Sinus	1	.4%					1	.2%
	Sinus Tachycardia	1	.4%					1	.2%
	Sinus Bradycardia	5	2.2%			1	1.2%	6	1.4%
	Ventricular Tachycardia	1	.4%	3	2.3%	1	1.2%	5	1.1%
	Ventricular Fibrillation	82	35.5%	48	37.5%	40	49.4%	170	38.6%
	Asystole	98	42.4%	54	42.2%	31	38.3%	183	41.6%
	Idioventricular Rhythm	7	3.0%			1	1.2%	8	1.8%
	Pulseless Electrical Activity	36	15.6%	23	18.0%	5	6.2%	64	14.5%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 21 - Bystander CPR by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Bystander CPR	Yes	33	14.3%	31	24.2%	17	21.0%	81	18.4%
	No	101	43.7%	35	27.3%	36	44.4%	172	39.1%
	Unknown	26	11.3%	33	25.8%	12	14.8%	71	16.1%
	By Health Care Provider	71	30.7%	29	22.7%	16	19.8%	116	26.4%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 22 - Dead at Scene by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
DOA	No	199	86.1%	105	82.0%	75	92.6%	379	86.1%
	Yes	32	13.9%	23	18.0%	6	7.4%	61	13.9%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 23 - Witnessed Cardiac Arrest by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Witnessed Cardiac Arrest	Yes	77	33.3%	42	32.8%	29	35.8%	148	33.6%
	No	75	32.5%	21	16.4%	19	23.5%	115	26.1%
	Unknown	51	22.1%	45	35.2%	26	32.1%	122	27.7%
	By Health Care Provider	28	12.1%	20	15.6%	7	8.6%	55	12.5%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 24 - Transportation by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Transport	No	35	15.2%	22	17.2%	9	11.1%	66	15.0%
	Yes	196	84.8%	106	82.8%	72	88.9%	374	85.0%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 25 - Life Support Given by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Life Support Given	ALS	212	91.8%	116	90.6%	76	93.8%	404	91.8%
	BLS	1	.4%	6	4.7%	1	1.2%	8	1.8%
	None	18	7.8%	6	4.7%	4	4.9%	28	6.4%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 26 - Pulse on Arrival by Professional Status
Resuscitation Attempted Cases

		Professional Status						Table Total	
		Paid		Volunteer		Combination			
		Count	Col %	Count	Col %	Count	Col %	Count	Col %
Pulse on Arrival	No	181	78.4%	104	81.3%	61	75.3%	346	78.6%
	Yes	50	21.6%	24	18.8%	20	24.7%	94	21.4%
Table Total		231	100.0%	128	100.0%	81	100.0%	440	100.0%

Table 27 - Time Call Received-To-Time First Defibrilation Interval (Minutes)

	Attempted Resusciation Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	85	47	46	41	172	134
Mean	9.87	8.70	11.85	8.05	9.97	9.58
Standard Deviation	6.03	3.74	8.02	6.16	6.75	6.39
Minimum	3.0	3.0	-3.0	2.0	-3.0	-3.0
Lower Quartile	6.0	6.0	8.0	3.5	6.0	6.0
Median	8.0	8.0	9.5	7.0	8.0	8.0
Upper Quartile	11.0	9.0	14.0	10.0	11.0	11.0
Maximum	34.0	23.0	46.0	29.0	46.0	46.0
Interquartile Range	5.0	3.0	6.0	6.5	5.0	5.0
Range	31.0	20.0	49.0	27.0	49.0	49.0

Table 28 - Time Call Received-To-Time First Epinephrine Dose Interval (Minutes)

	Attempted Resusciation Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	207	101	100	60	367	261
Mean	18.20	18.46	21.04	15.97	18.61	18.87
Standard Deviation	12.65	15.55	8.44	9.98	11.33	12.10
Minimum	1.0	1.0	4.0	2.0	1.0	1.0
Lower Quartile	11.0	11.0	15.0	10.0	12.0	12.0
Median	16.0	16.0	20.0	14.0	16.0	17.0
Upper Quartile	21.0	20.5	25.0	20.0	22.0	23.0
Maximum	142.0	142.0	47.0	67.0	142.0	142.0
Interquartile Range	10.0	9.5	10.0	10.0	10.0	11.0
Range	141.0	141.0	43.0	65.0	141.0	141.0

Table 29 - Time Call Received-To-Time Arrive Destination Interval (Minutes)

	Attempted Resusciation Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	200	103	98	69	367	270
Mean	55.55	67.27	77.46	65.87	63.34	70.61
Standard Deviation	22.16	23.41	30.75	26.22	27.08	27.38
Minimum	20.0	20.0	13.0	18.0	13.0	13.0
Lower Quartile	37.0	45.0	63.0	38.0	40.0	46.0
Median	49.0	76.0	82.0	74.0	66.0	78.0
Upper Quartile	76.0	85.0	92.0	86.0	84.0	87.0
Maximum	113.0	113.0	193.0	128.0	193.0	193.0
Interquartile Range	39.0	40.0	29.0	48.0	44.0	41.0
Range	93.0	93.0	180.0	110.0	180.0	180.0

Table 30 - Pulse on Arrival by Witnessed Cardiac Arrest
Resuscitation Attempted Cases

		Pulse on Arrival						Table Total		
		No			Yes					
		Count	Col %	Row %	Count	Col %	Row %	Count	Col %	Row %
Witnessed Cardiac Arrest	Yes	104	30.1%	70.3%	44	46.8%	29.7%	148	33.6%	100.0%
	No	104	30.1%	90.4%	11	11.7%	9.6%	115	26.1%	100.0%
	Unknown	99	28.6%	81.1%	23	24.5%	18.9%	122	27.7%	100.0%
	By Health Care Provider	39	11.3%	70.9%	16	17.0%	29.1%	55	12.5%	100.0%
Table Total		346	100.0%	78.6%	94	100.0%	21.4%	440	100.0%	100.0%

Table 31 - Pulse on Arrival by Bystander CPR
Resuscitation Attempted Cases

		Pulse on Arrival						Table Total		
		No			Yes					
		Count	Col %	Row %	Count	Col %	Row %	Count	Col %	Row %
Bystander CPR	Yes	62	17.9%	76.5%	19	20.2%	23.5%	81	18.4%	100.0%
	No	143	41.3%	83.1%	29	30.9%	16.9%	172	39.1%	100.0%
	Unknown	56	16.2%	78.9%	15	16.0%	21.1%	71	16.1%	100.0%
	By Health Care Provider	85	24.6%	73.3%	31	33.0%	26.7%	116	26.4%	100.0%
Table Total		346	100.0%	78.6%	94	100.0%	21.4%	440	100.0%	100.0%

Table 32 - Pulse on Arrival by First Response Units
Resuscitation Attempted Cases

		Pulse on Arrival						Table Total		
		No			Yes					
		Count	Col %	Row %	Count	Col %	Row %	Count	Col %	Row %
First Response Units	Yes	154	44.5%	79.0%	41	43.6%	21.0%	195	44.3%	100.0%
	No	94	27.2%	81.7%	21	22.3%	18.3%	115	26.1%	100.0%
	Unknown	59	17.1%	70.2%	25	26.6%	29.8%	84	19.1%	100.0%
	N/A	39	11.3%	84.8%	7	7.4%	15.2%	46	10.5%	100.0%
Table Total		346	100.0%	78.6%	94	100.0%	21.4%	440	100.0%	100.0%

Tables 33 through 36

Resuscitation Attempted and Witnessed Cardiac Arrest Reports

Table 33 - Time Call Received-To-Time Arrive Scene Interval (Minutes)

	Attempted Resusciation, Witnessed Attack Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	77	34	39	26	142	99
Mean	7.26	9.44	19.03	12.50	11.45	14.02
Standard Deviation	7.98	11.45	18.83	17.45	14.48	16.65
Minimum	0.0	0.0	3.0	2.0	0.0	0.0
Lower Quartile	4.0	4.0	8.0	3.0	4.0	4.0
Median	5.0	5.0	11.0	4.0	6.0	8.0
Upper Quartile	8.0	8.0	16.0	10.0	10.0	13.0
Maximum	46.0	46.0	72.0	59.0	72.0	72.0
Interquartile Range	4.0	4.0	8.0	7.0	6.0	9.0
Range	46.0	46.0	69.0	57.0	72.0	72.0

Table 34 - Time Call Received-To-Time First Defibrilation Interval (Minutes)

	Attempted Resusciation, Witnessed Attack Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	38	21	19	18	75	58
Mean	9.16	8.57	12.53	8.67	9.89	9.90
Standard Deviation	3.59	3.25	7.95	6.86	5.92	6.41
Minimum	4.0	5.0	3.0	2.0	2.0	2.0
Lower Quartile	7.0	6.0	8.0	5.0	6.0	6.0
Median	8.5	8.0	9.0	6.5	9.0	8.0
Upper Quartile	10.0	9.0	15.0	10.0	11.0	11.0
Maximum	19.0	18.0	35.0	29.0	35.0	35.0
Interquartile Range	3.0	3.0	7.0	5.0	5.0	5.0
Range	15.0	13.0	32.0	27.0	33.0	33.0

Table 35 - Time Call Received-To-Time First Epinephrine Dose Interval (Minutes)

	Attempted Resusciation, Witnessed Attack Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	72	29	33	21	126	83
Mean	16.21	15.76	20.79	18.90	17.86	18.55
Standard Deviation	6.76	6.00	6.35	13.86	8.43	8.93
Minimum	1.0	1.0	8.0	2.0	1.0	1.0
Lower Quartile	11.0	11.5	17.0	10.5	12.0	14.0
Median	15.5	16.0	20.0	17.0	17.0	18.0
Upper Quartile	19.0	19.0	24.0	23.5	21.0	23.0
Maximum	38.0	30.0	36.0	67.0	67.0	67.0
Interquartile Range	8.0	7.5	7.0	13.0	9.0	9.0
Range	37.0	29.0	28.0	65.0	66.0	66.0

Table 36 - Time Call Received-To-Time Arrive Destination Interval (Minutes)

	Attempted Resusciation, Witnessed Attack Patients Only				Table Total	
	Paid				All Agencies	
Statistic	All	Exclude 3	Volunteer	Combination	All	Exclude 3
N	65	29	32	24	121	85
Mean	53.29	66.21	80.50	68.04	63.41	72.11
Standard Deviation	22.86	26.28	28.25	26.49	27.51	27.58
Minimum	20.0	22.0	31.0	19.0	19.0	19.0
Lower Quartile	36.0	41.0	72.0	45.0	39.0	49.0
Median	47.0	76.0	84.0	72.0	67.0	78.0
Upper Quartile	72.0	89.0	87.0	87.0	84.0	87.0
Maximum	113.0	113.0	193.0	128.0	193.0	193.0
Interquartile Range	36.0	48.0	15.0	42.0	45.0	38.0
Range	93.0	91.0	162.0	109.0	174.0	174.0

Appendix B

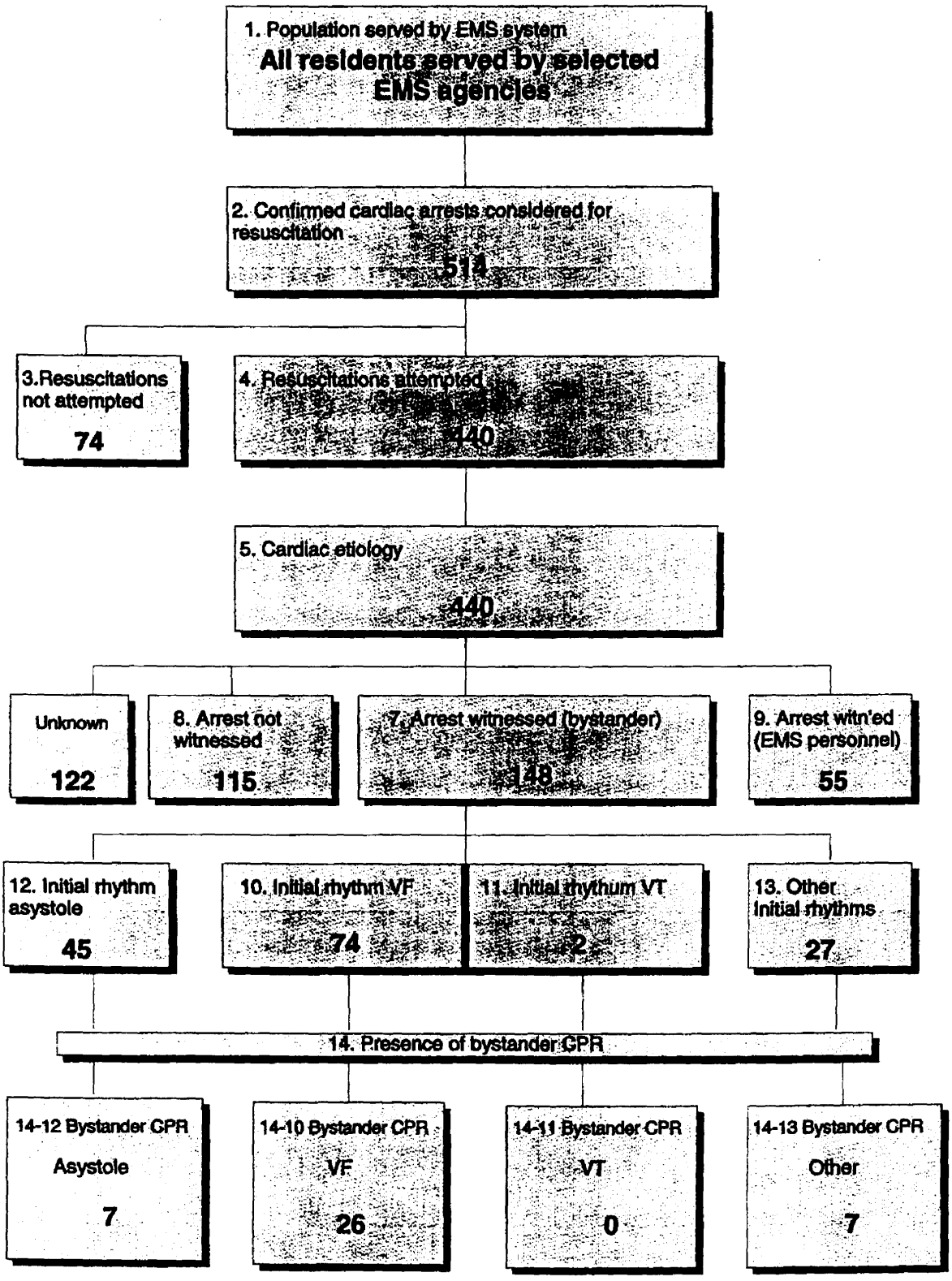
Table 1 - Dead on Arrival/Dead at Scene
Resuscitation Attempted Cases

		Resuscitation Attempted				Table Total	
		No		Yes			
		Count	Row %	Count	Row %	Count	Row %
Agency	Dante Rescue Squad	1	100.0%			1	100.0%
	Roanoke Fire-EMS Dept			1	100.0%	1	100.0%
	Woodstock Volunteer	1	100.0%			1	100.0%
	Charlottesville-Albemarle EMS	5	35.7%	9	64.3%	14	100.0%
	Lake Monticelo Volunteer			2	100.0%	2	100.0%
	Manchester Volunteer	4	100.0%			4	100.0%
	Bridgewater Volunteer	1	100.0%			1	100.0%
	Fredericksburg Rescue Squad	3	75.0%	1	25.0%	4	100.0%
	Tappahannock Volunteer	1	100.0%			1	100.0%
	Abingdon Volunteer			1	100.0%	1	100.0%
	Mathews Volunteer	3	100.0%			3	100.0%
	Southside Virginia Emergency Crew	1	25.0%	3	75.0%	4	100.0%
	Nansemond-Suffolk Volunteer	1	50.0%	1	50.0%	2	100.0%
	Ocean Park Volunteer			1	100.0%	1	100.0%
	Virginia Beach Volunteer			1	100.0%	1	100.0%
	Plaza Volunteer			2	100.0%	2	100.0%
	Kempsville Volunteer			2	100.0%	2	100.0%
	Princess Anne Courthouse			2	100.0%	2	100.0%
	James City County	10	100.0%			10	100.0%
	Newport News Fire Dept	12	85.7%	2	14.3%	14	100.0%
	Chesapeake Beach Fire			1	100.0%	1	100.0%
	Buckroe Beach Volunteer	3	100.0%			3	100.0%
	Hampton Division	17	100.0%			17	100.0%
	Davis Corner Volunteer			2	100.0%	2	100.0%
	Roanoke County Fire	1	100.0%			1	100.0%
	Chesapeake Fire Dept			2	100.0%	2	100.0%
	Colonial Heights Fire/EMS			4	100.0%	4	100.0%
	Chesterfield Fire			7	100.0%	7	100.0%
	Richmond Ambulance	1	5.6%	17	94.4%	18	100.0%
	Goochland County Fire	1	100.0%			1	100.0%
Table Total		66	52.0%	61	48.0%	127	100.0%

Appendix C

Utstein Style Templates

Utstein Style Template



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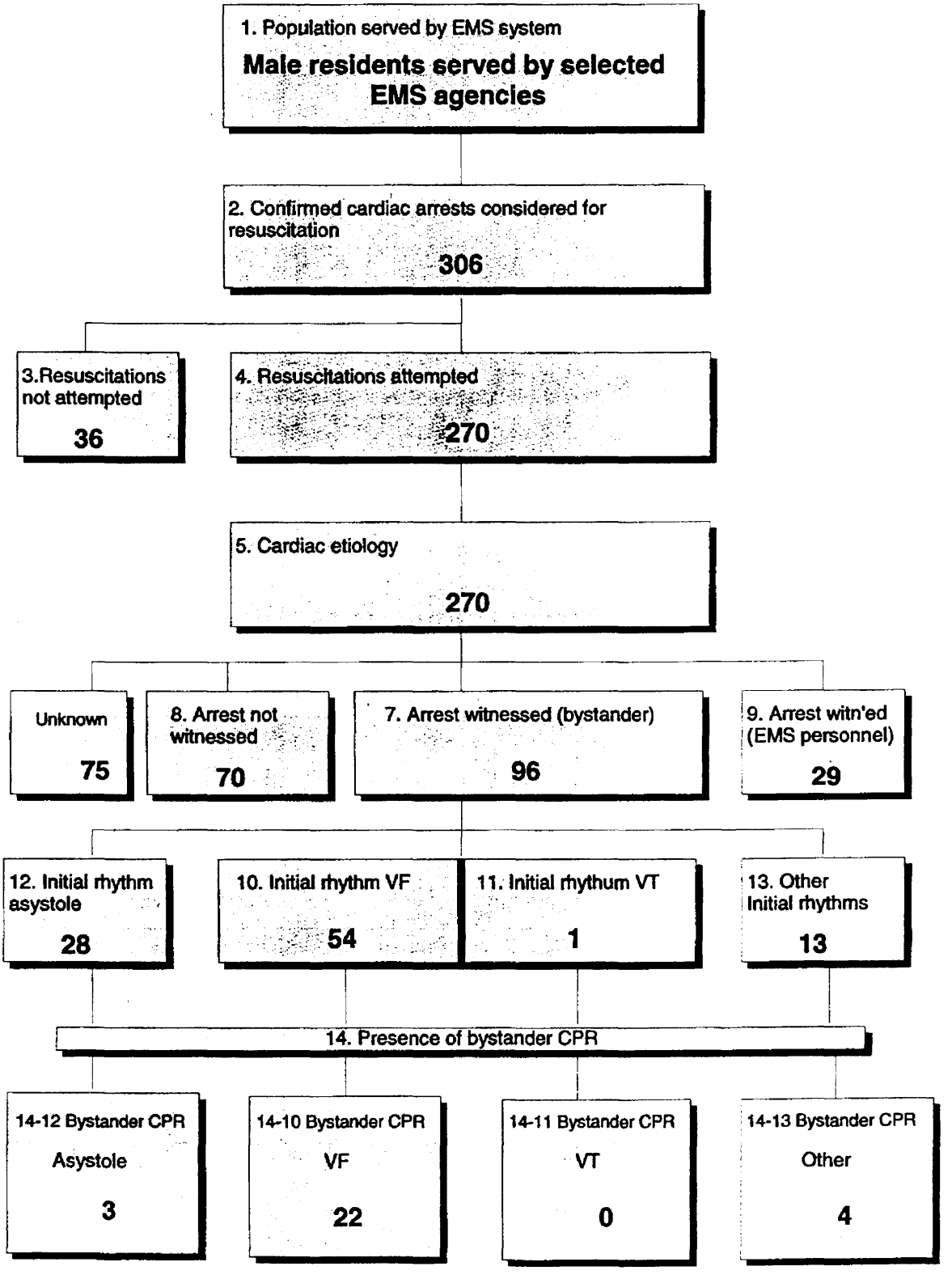

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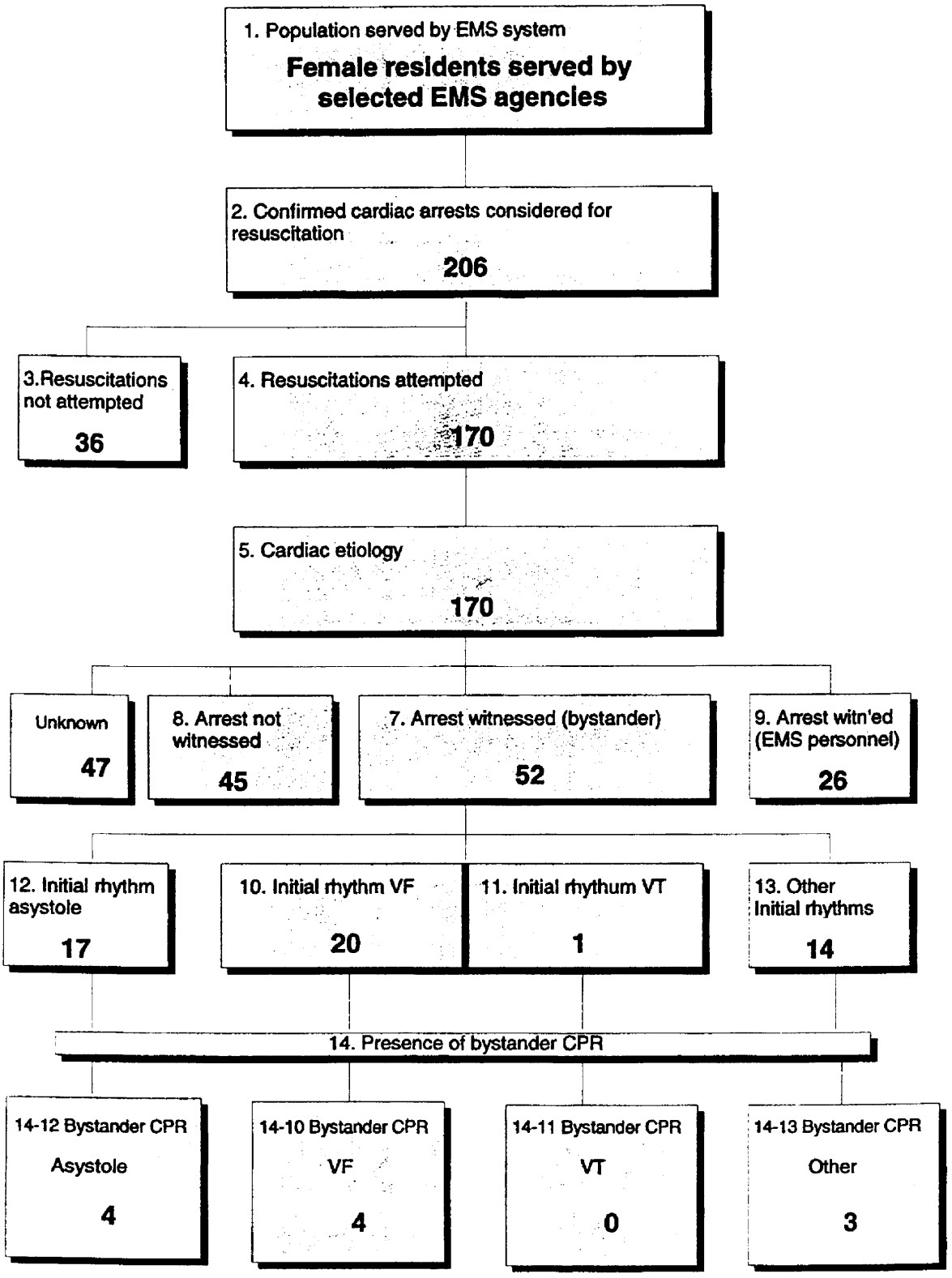

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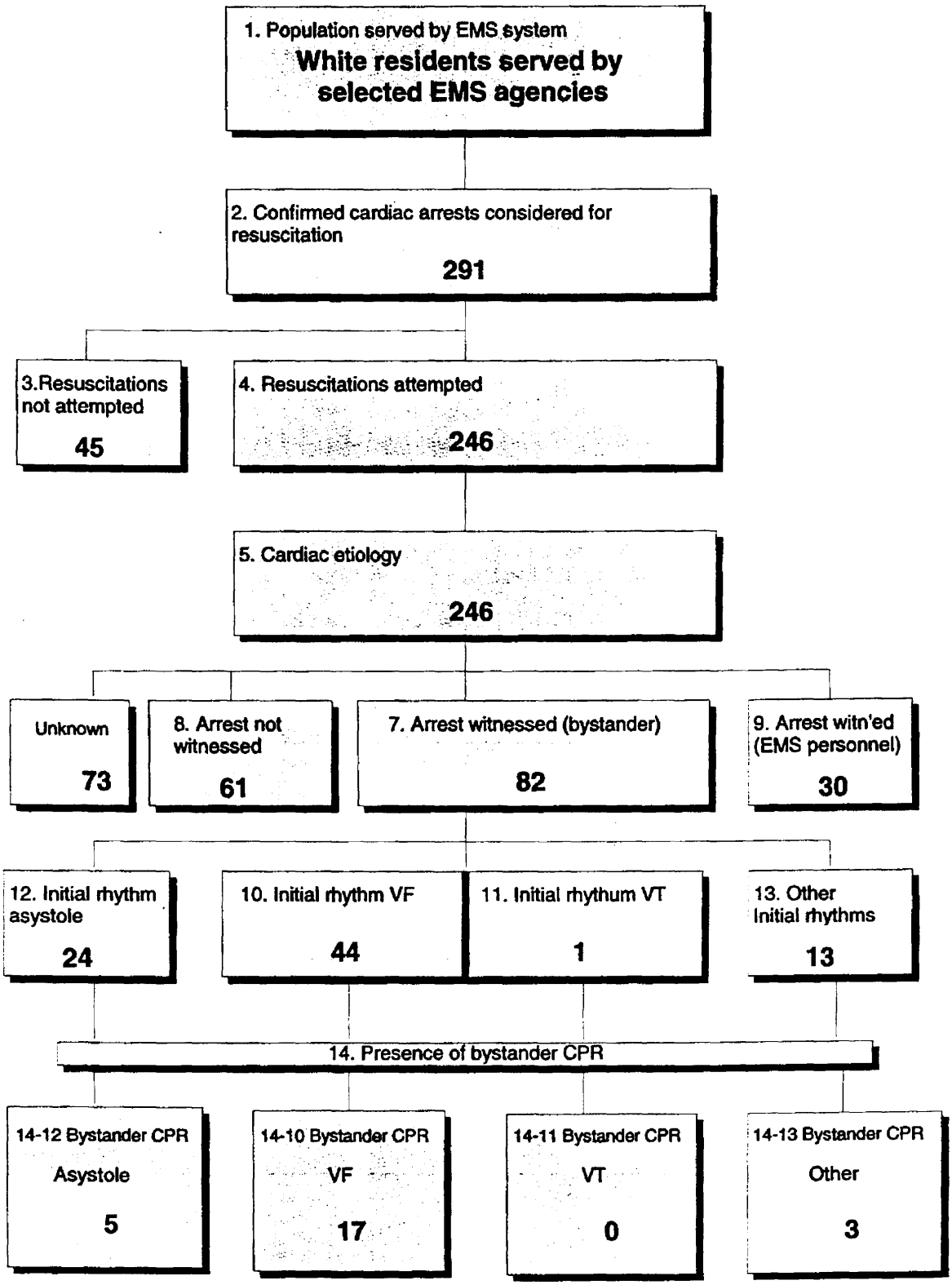

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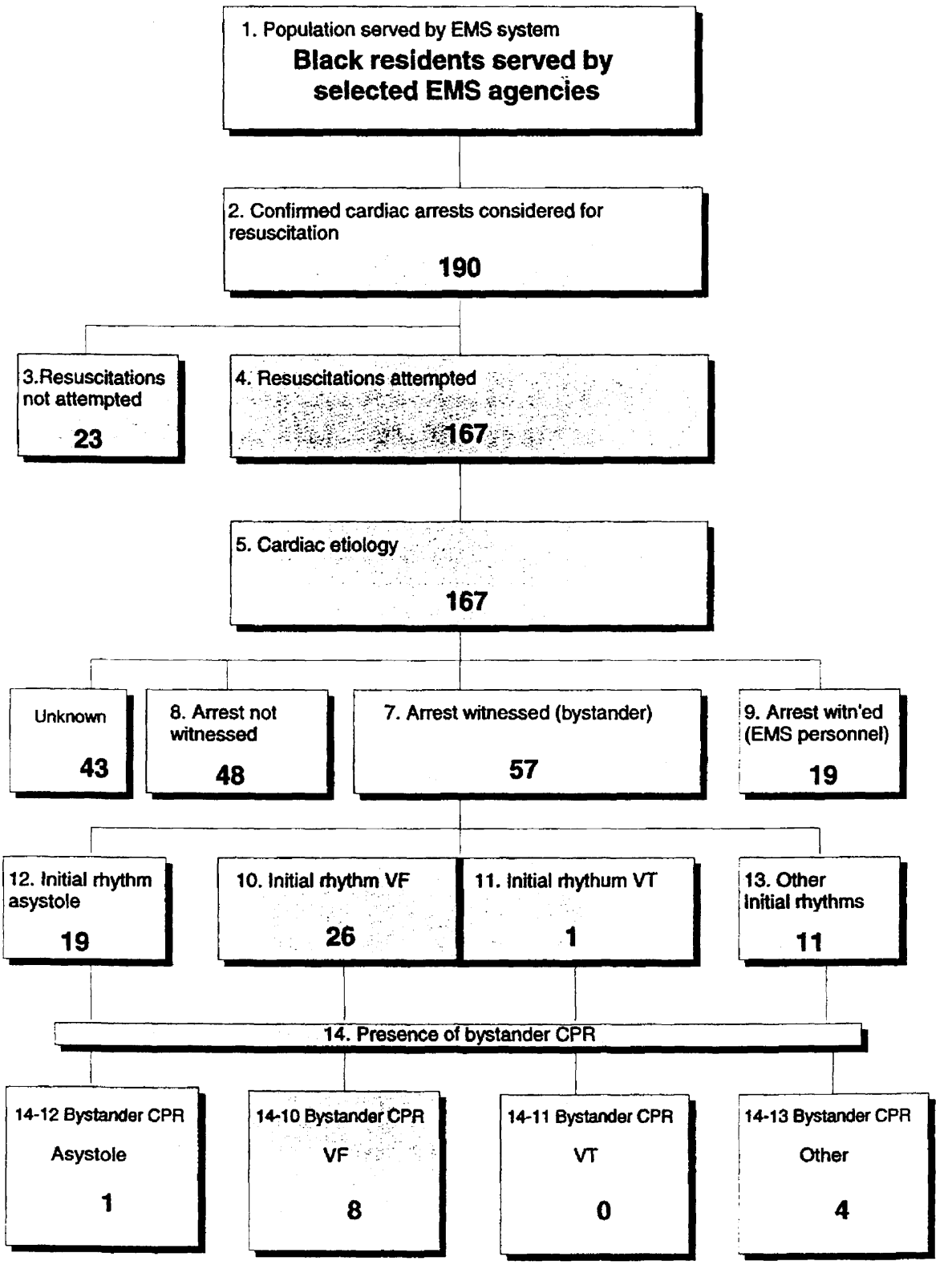

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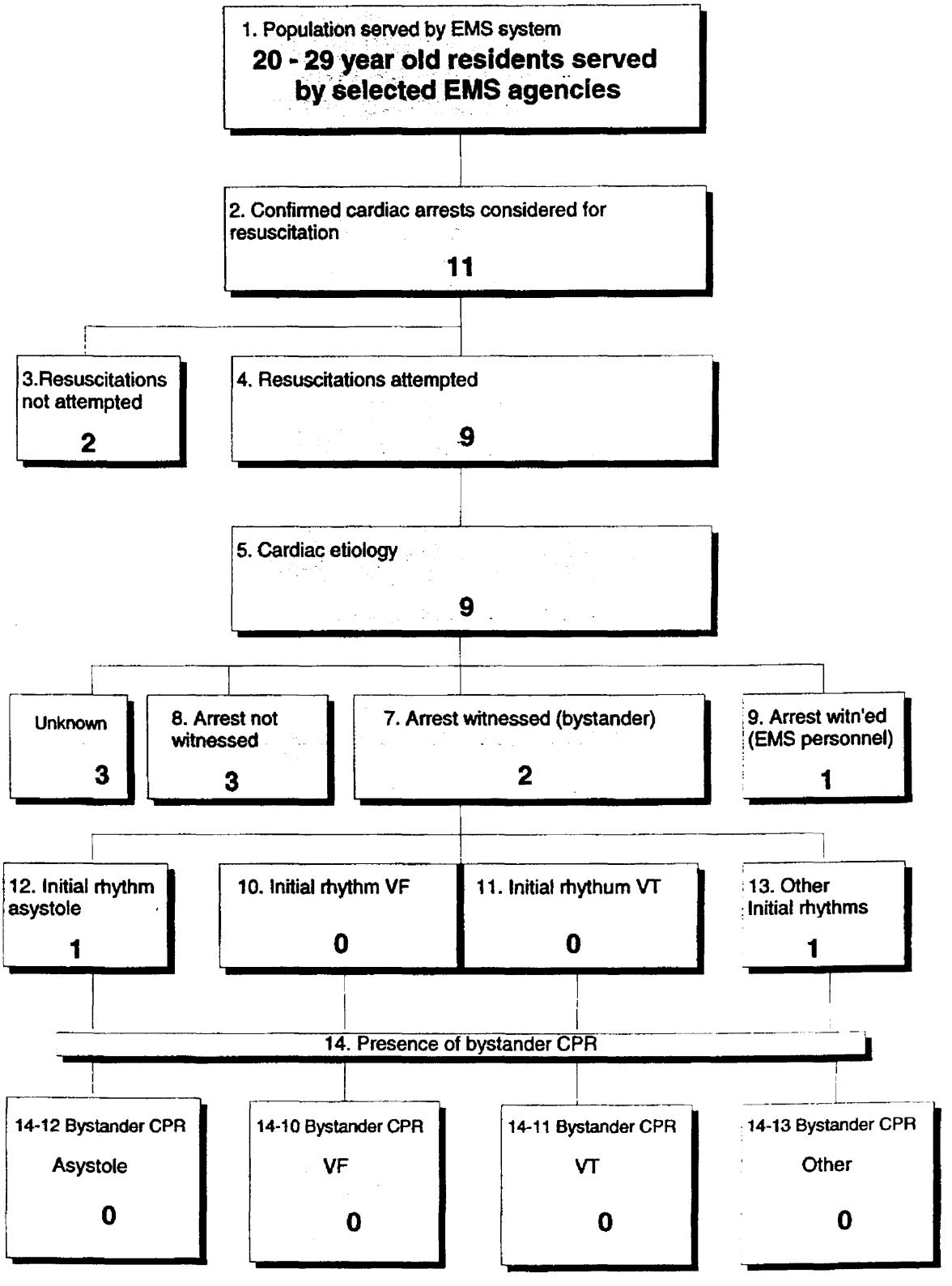

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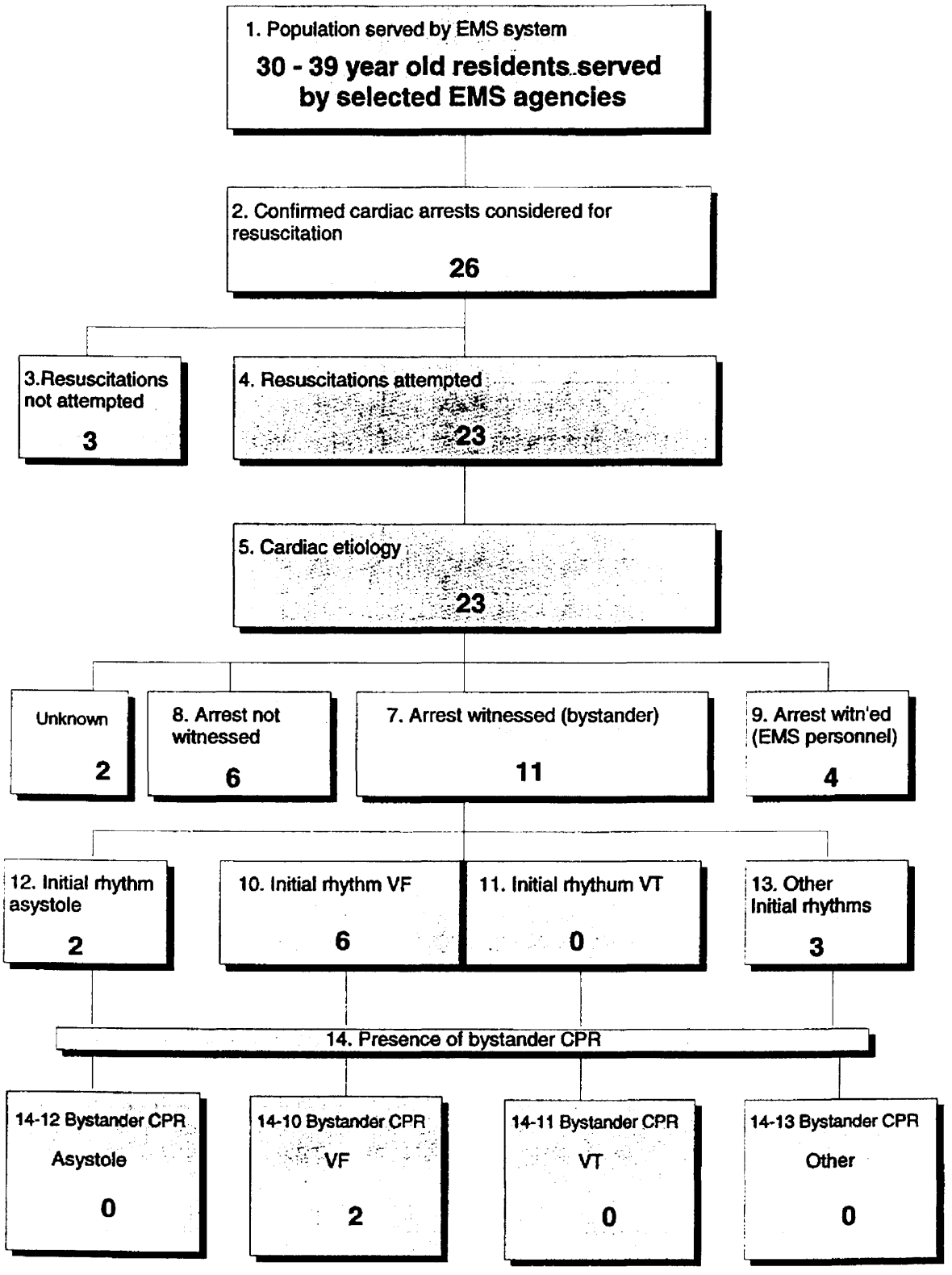

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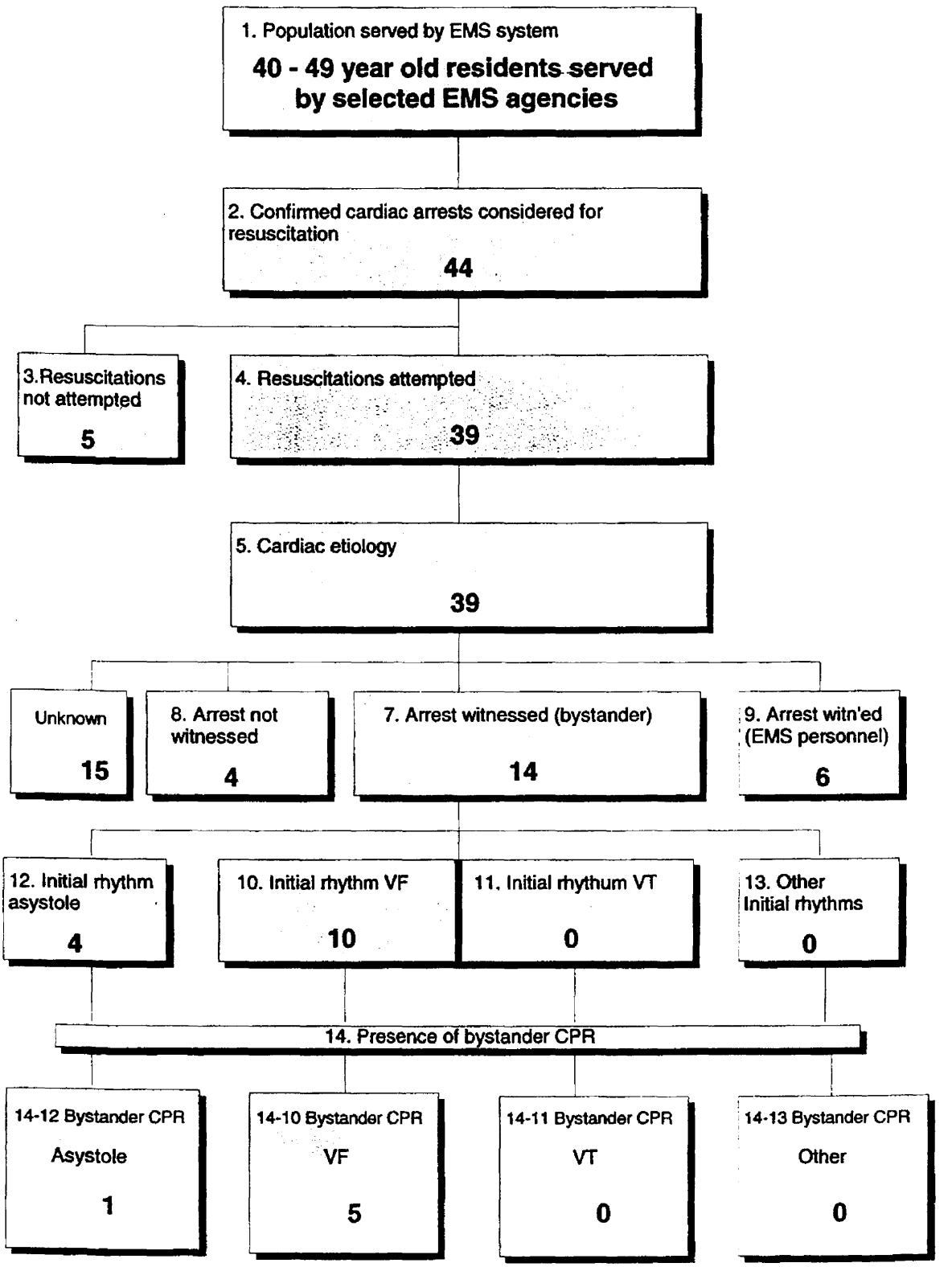

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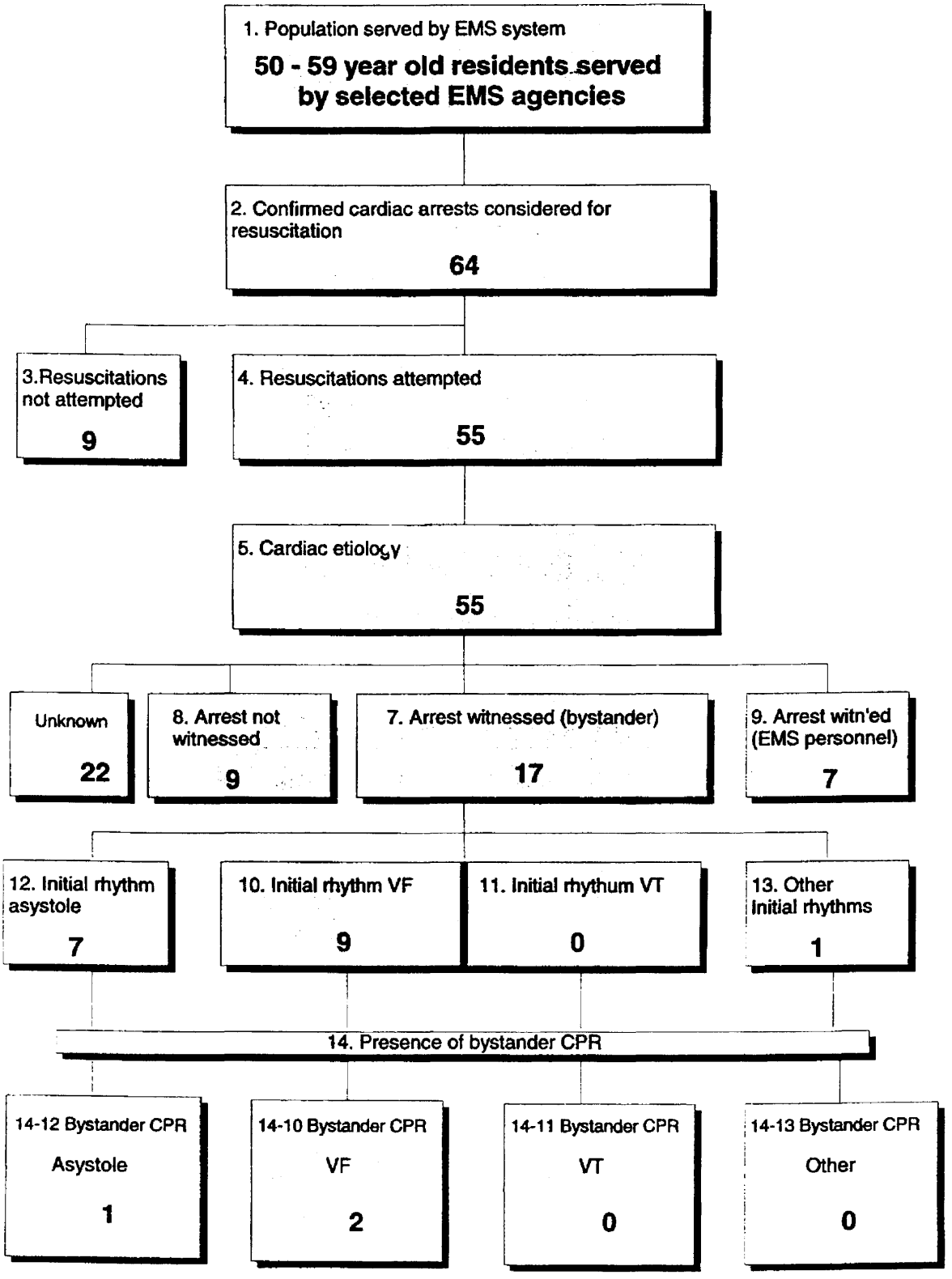

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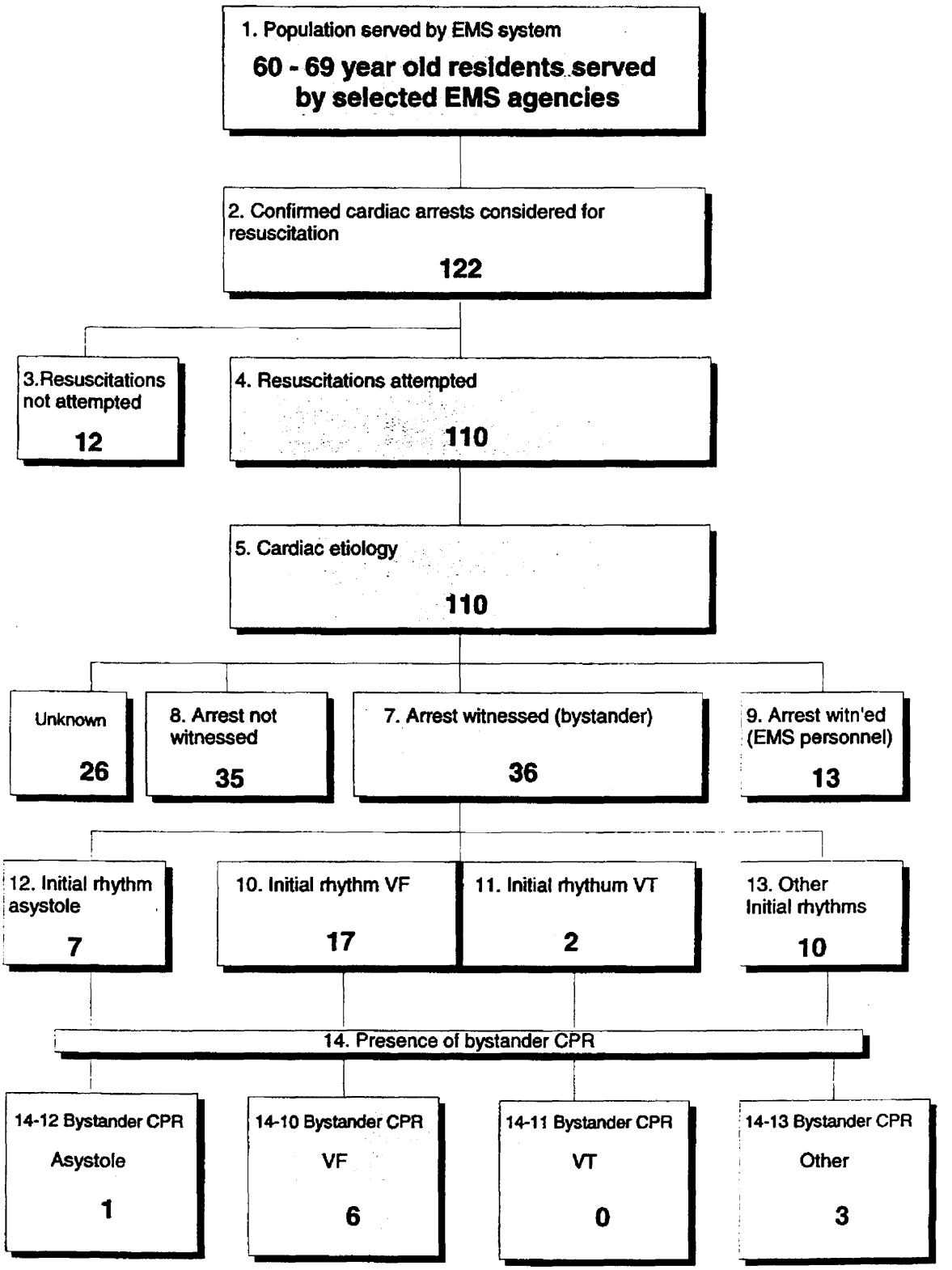

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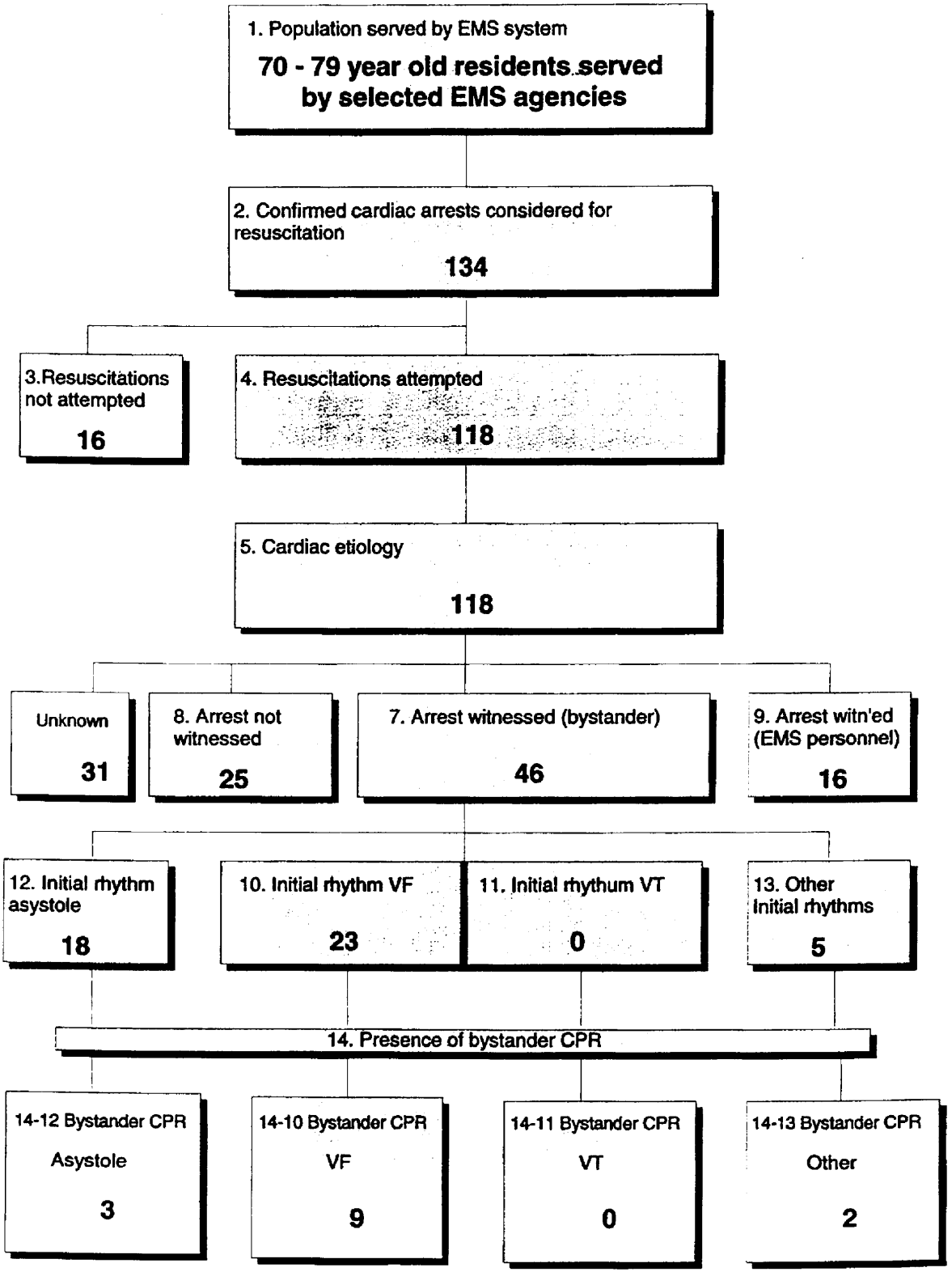

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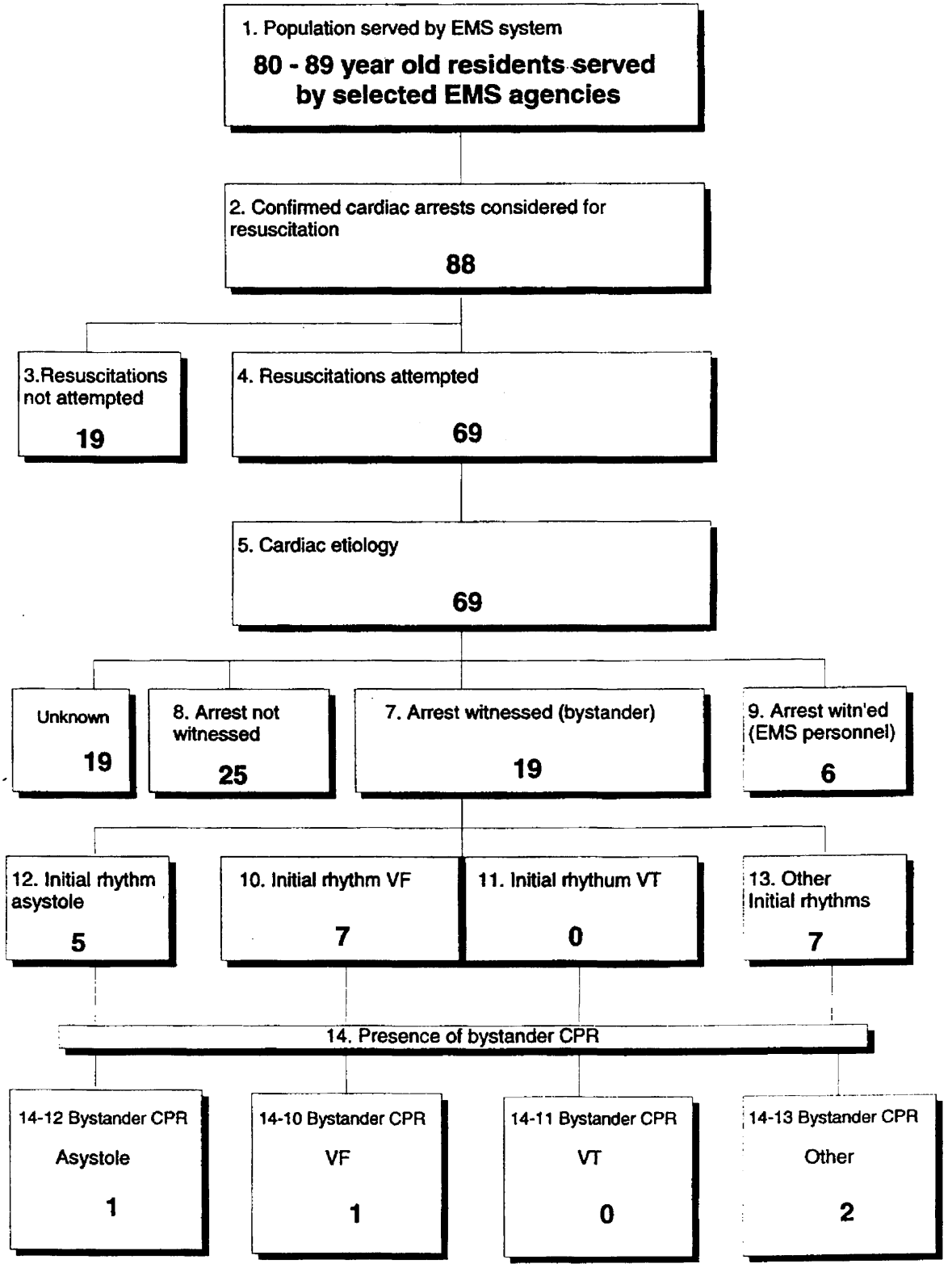

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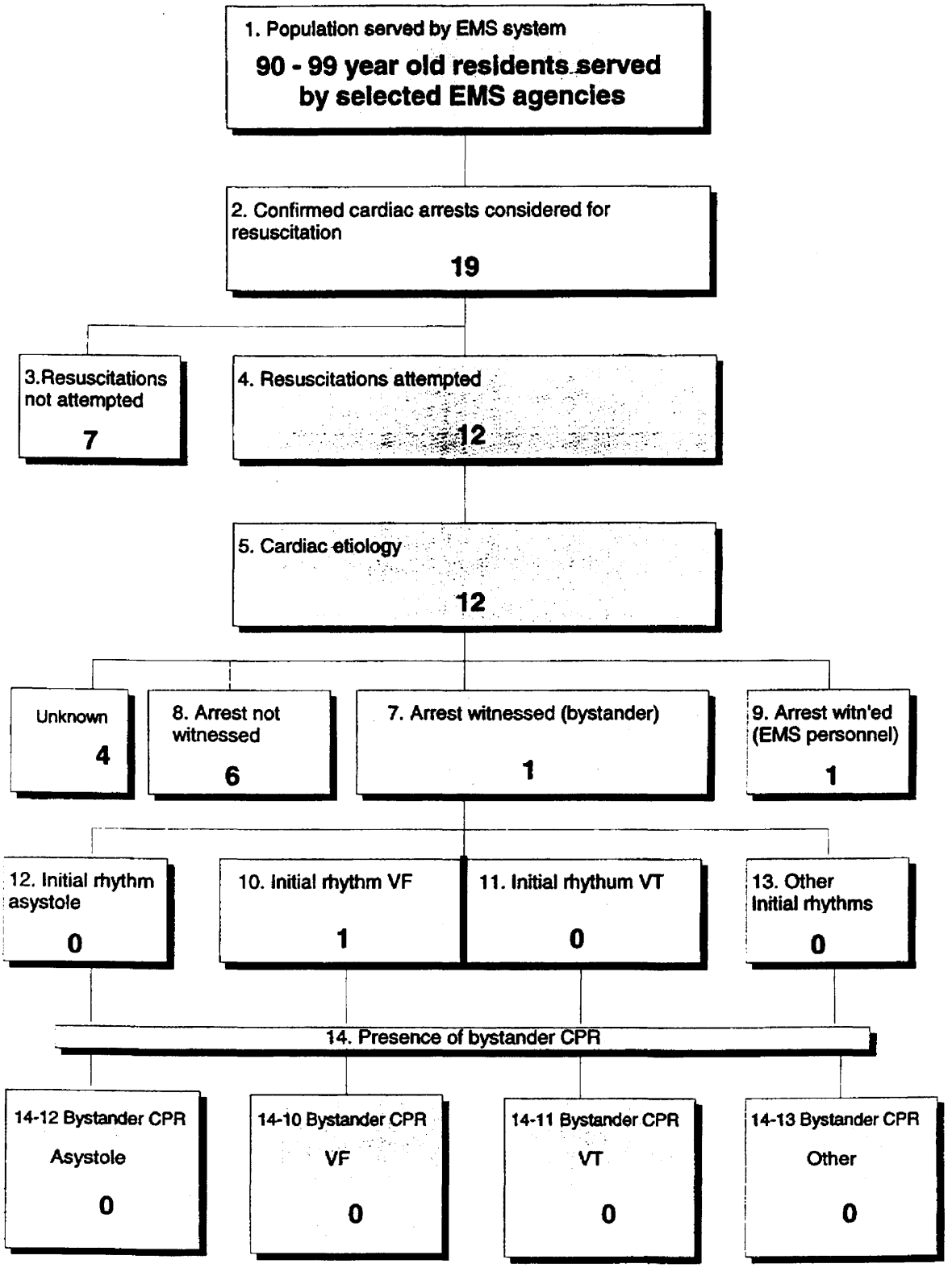

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