OFFICE OF APPLIED STUDIES

Drug Abuse Warning Network: Development of a New Design

Methodology Report

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Substance Abuse and Mental Health Services Administration
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INTRODUCTION

It will be a continuing and dynamic effort, which will be constantly reviewed and modified to obtain more precise information (Bartels, 1973).

This was the vision articulated for the Drug Abuse Warning Network (DAWN) upon publication of its first findings in 1973. This is also the vision of DAWN we hold today. But for many of the intervening 30 years, DAWN failed to live up to its promise. This publication contains a series of reports and analyses developed as part of a two-year evaluation of design alternatives, which has returned DAWN to its original vision and has forged for DAWN a new set of purposes and approaches for the 21st century.

The Drug Abuse Warning Network (DAWN) is an important source of national and local information on substance abuse. This information is derived from data on visits to hospital emergency departments (EDs) and drug-related deaths reviewed by medical examiners and coroners (ME/Cs). DAWN collects data on the demographic characteristics of substance abusers and the specific drugs involved in each drug-related ED visit or death. The detail available on specific drugs is not matched by any other data system. Currently, DAWN is managed by the Office of Applied Studies (OAS), a component of the Substance Abuse and Mental Health Services Administration (SAMHSA) within the U.S. Department of Health and Human Services. SAMHSA is directed under Section 505 of the Public Health Service Act (42 U.S.C. 290aa-4(c)(1) to collect such data.

Defining the purpose(s) of DAWN was central to redesigning the system. The redesign process began formally on November 10, 1997, when OAS convened an expert panel to consider the future of DAWN and the need for a new design. Perhaps the most obvious and the most critical purpose of DAWN is its warning capacity. DAWN is intended to serve as a first indicator of the serious consequences of drug use in the 21 metropolitan areas served by DAWN. During its three decades of operation, however, this purpose has been met inadequately at best.

DAWN data are used for many other purposes with varying degrees of success, appropriateness, and satisfaction. The purposes for which DAWN is well suited include drug scheduling and drug labeling, quantifying the extent of the nation's drug problem, assessing effectiveness of local anti-drug efforts, guiding resource allocation decisions, surveillance of local area drug trends, documentation of drug problems and trends, and as a data source for academic research on drug abuse. Often, however, individuals used DAWN for purposes contrary to its design, and DAWN was frequently criticized for failing to meet such purposes.

DAWN's inability to fulfill its primary purposes reflects more than a mere misunderstanding of what DAWN was designed to accomplish. During its three decades of operation, much of the original structure and many of the operations continued much as they had at the beginning, even though the needs of the data users and the health care environment had changed. Clearly, technological barriers prevented DAWN from realizing its warning purpose in the 1970s and 1980s. However, when technologies to enable rapid data collection and dissemination became the norm, DAWN continued to use paper forms for data collection. The time required to collect, process, and analyze data collected in this way defeated any hope of realizing an early

warning capability, and dissemination of information back to communities was simply not a high priority.

Mindful of these limitations, SAMHSA convened the 1997 review panel to consider the utility of DAWN and whether changes in the health care delivery system, particularly the growth of managed care, had diluted the value of emergency departments as a setting for collecting data on drug abuse. The panel, which could have called for DAWN's elimination, recommended instead that SAMHSA update its procedures and prepare DAWN for the 21st century.

In response, OAS undertook the comprehensive two-year evaluation of DAWN. This evaluation resulted in recommendations for a new design for DAWN. Using a wide range of study methods, the evaluation addressed the following questions:

- Who are the users of DAWN data and what information do they need?
- Does DAWN collect data from the right settings?
- Does DAWN collect data on the right set of patients?
- Does DAWN collect the right data on those patients?
- How can DAWN use technology to collect data more efficiently?
- How can DAWN deliver information more effectively?

These questions challenged the fundamental approaches long used by this survey. This publication presents some of the findings used to improve DAWN's design, guided by these important questions.

The first chapter discusses the development of an alternative design to DAWN, including limitations of the current design, the scope of the redesign activities, and key issues. The second chapter assesses the impact of health system change on DAWN, through a comprehensive review of the literature, analyses of national data, and qualitative research on local health system impacts. The third chapter discusses the development of a new sample design for DAWN. Finally, the fourth chapter discusses the redesign of DAWN's case definitions, data elements, and case screening procedures.

REFERENCES

Bartels, J. R. (1973). *Drug Abuse Warning Network (DAWN I Analysis)*, Interim Report under BNDD Contract No. 72-47, Drug Enforcement Administration.

1. DEVELOPMENT OF AN ALTERNATIVE DESIGN FOR DAWN

The Drug Abuse Warning Network (DAWN) was implemented nearly 30 years ago to support a specific set of Federal policy-making purposes. Over time, the agencies responsible for the maintenance of DAWN have changed, operational approaches have been modified, and the uses for DAWN data have expanded. First administered by the Drug Enforcement Administration (DEA) and the National Institute on Drug Abuse (NIDA), the responsibility for DAWN now rests with the Office of Applied Studies (OAS) of the Substance Abuse and Mental Health Services Administration (SAMHSA). In the 1980s, improvements in the sampling design were made to accommodate both local (metropolitan area) and Federal-level needs for data. In addition, the hospitals in the sample were assigned weights to permit the calculation of national estimates of drug-related emergency department visits and specific drug mentions. At the same time, the health care system has changed dramatically, as have the needs of DAWN's users. However, the day-to-day operations of DAWN have changed remarkably little over the past 3 decades.

With the exception of the sample design and estimation procedures (described in detail in SAMHSA, 1998), the history of DAWN is neither well documented nor widely understood. Many of the current design features of the system are historical artifacts (e.g., certain data elements, the oversampled metropolitan areas, etc.), but there are many who incorrectly assume that these features reflect a specific rationale or intent on the part of OAS. The complexities and limitations of the system, coupled with lack of detailed historical documentation, lead to inevitable misinterpretation of DAWN data, as well as criticism that sometimes is well grounded and sometimes is not. Through an extensive DAWN redesign process, OAS sought to improve both the structure of the system and the public perception of DAWN.

LIMITATIONS OF THE CURRENT DESIGN

The value of DAWN for Federal and local policy-making is considerable but not well advertised, while the limitations of the system are often overemphasized by constituencies DAWN was not designed to serve. In 1995, the Rand Corp. published a report articulating many of the criticisms that have been leveled against DAWN in recent years (Caulkins, Ebener, & McCaffrey, 1995). That report was soon followed by a 1997 review panel, convened by OAS to assess the value and future prospects for DAWN. Those reviews highlighted the problems needing to be resolved with DAWN if the system is to achieve what was thought to be its considerable potential.

Caulkins et al. identified a number of problems, limitations, and misconceptions about DAWN, including the following:

- There was little public documentation of DAWN's data quality, and a few published studies raised concerns that measurement error in DAWN was substantial and systemic.

- Because DAWN monitors episodes, not individuals, data are misinterpreted if analysts view them as prevalence measures.

- There is an uncertain, and perhaps inconsistent, relationship between the number of DAWN episodes and the true level of drug abuse problems in a given area.

- Delays in reporting DAWN data undermined its potential utility as an early warning mechanism for emerging drug problems.

- DAWN data were often assumed to represent heavy or chronic drug users, although the validity of that assumption has never been assessed.

The report concluded that DAWN was used for purposes it was not designed to serve, while at the same time its strengths were not fully appreciated or taken advantage of.

In 1997, OAS convened two review panels to consider the future of DAWN and the need for a new design. The first panel, convened to consider the uses and limitations of DAWN, consisted largely of Federal staff from OAS, the Food and Drug Administration (FDA), DEA, and the Office of National Drug Control Policy (ONDCP); in addition, two epidemiologists, a medical examiner, and several drug abuse researchers contributed to the group's deliberations. The second panel, convened to consider the implications of health system change for DAWN, consisted of representatives from several managed behavioral health care organizations, a drug abuse treatment provider, an emergency physician, and drug abuse and health system researchers, along with staff from OAS and the Agency for Health Care Policy and Research (AHCPR, now the Agency for Healthcare Research and Quality [AHRQ]). Each group gathered for a full-day meeting to identify the strengths and limitations of DAWN and to prioritize redesign efforts.

Importantly, the two groups agreed that DAWN was a valuable system that, with certain changes, would have much to offer the policy, programming, and research communities. However, it was clear that there was substantial work to be done to develop and implement a new design. Together, the two groups identified the following issues that needed to be addressed in a redesign of DAWN:

- DAWN suffered from substantial report production lags, such that data were often too old to be useful by the time reports were published. How could DAWN be made more timely?

- DAWN was intended to be a warning system but generally failed to achieve that function. Aside from the timeliness of published reports, how could DAWN more rapidly gather, identify, and disseminate information about emerging drug trends? Could DAWN effectively serve as a leading indicator of drug abuse trends?

- DAWN's utility seemed to be under-appreciated at the local level. Were there local audiences for DAWN data, and how could DAWN be designed to better meet their needs?

- There was little feedback of data or information to participating facilities, which affected participation, recruitment efforts, and a sense of investment in the system. How might DAWN provide useful, timely feedback to facilities and communities?

- The U.S. healthcare system had undergone substantial changes since DAWN's inception in 1972. What impact had ongoing changes in the health care system had on DAWN's ability to gather complete, accurate, and valid data from emergency departments? To what extent were emergency department (ED) data appropriate for identifying meaningful changes in drug abuse patterns?

In addition, it was clear from the transcripts of these meetings that DAWN's case definition (the rule used to define reportable cases) was difficult to explain, and therefore led to substantial confusion about what DAWN measured, the types of cases considered reportable, and how the data should be interpreted. Thus, another issue was how the system might be redesigned to ensure that the data were responsive to users' needs, able to be gathered consistently, and readily interpretable.

SCOPE OF THE REDESIGN ACTIVITIES

The DAWN Redesign task order grew out of the ideas and concerns expressed in the Caulkins et al. report and in the two OAS review panel meetings. The original task order posed the following questions:

(1) How can DAWN be made more useful in terms of predicting the patterns, trends, and consequences of substance abuse?

(2) How can the quality and timeliness of DAWN data collection and reporting be improved?

This chapter provides an overview of the activities undertaken to address to those questions, and the recommendations stemming from those activities. It should be noted that this chapter addresses design recommendations – that is, what changes should be made – and focuses less on specific methods for implementation of those recommendations. Some changes (e.g., improvements in the timeliness of published reports) were made by the DAWN team independent of the redesign activities; other changes (e.g., a redesign of the Medical Examiner report) were implemented by the redesign team; still other changes (e.g., implementation of an on-line sentinel event network) were beyond the scope of the redesign contract and will be the responsibility of the contractor awarded the operation of the new DAWN.

What is DAWN?

The Drug Abuse Warning Network is an ongoing, national data system that collects and reports information on adverse health consequences associated with drug abuse. Specifically, DAWN gathers data on drug abuse-related ED visits from a representative sample of hospitals in the coterminous United States, as well as data on drug abuse-related deaths reviewed by participating medical examiners and coroners (ME/Cs). DAWN is an important indicator of the nation's drug abuse problems. The structure, content, and operation of each component are briefly reviewed here.

DAWN collects data from a representative sample of 24-hour EDs operating in non-Federal, short-stay general medical/surgical hospitals throughout the coterminous United States. In 2000, about 470 EDs participated in DAWN. The ED sample is structured such that DAWN can provide estimates of the total number of drug abuse-related ED visits ("episodes") and the total

number of drug mentions for each of 21 selected metropolitan areas as well as the Nation. Because no attempt is made to identify unique individuals within or across EDs, the number of DAWN episodes will equal or exceed the number of individual persons treated for drug-related complications in the Nation's EDs.

DAWN also collects data from ME/Cs. In 2000, about 140 jurisdictions in 43 metropolitan areas provided data to DAWN. Each metropolitan area covers one or more death investigation jurisdictions. Coverage of jurisdictions varies from one metro area to the next. In a few areas, all jurisdictions report to DAWN; in other areas, less than half of all jurisdictions participate. Because the participating jurisdictions are not based on a statistical sample, their data cannot be used to generate estimates of the total number of drug-related deaths, either nationally or for the metropolitan areas.

In each participating facility, a designated DAWN "reporter" is asked to review the charts of all patients treated in the ED or decedents reviewed by the ME/C. The content and quality of patient/decedent charts vary from one facility to the next. ED charts generally include information on the presenting complaint, the nurse or physician's assessment, diagnosis, medications, and discharge status. ME charts include information pertinent to the death investigation, which may involve crime scene reports, police reports, interviews with family and friends, and autopsy results. Both ED and ME charts commonly contain the results of toxicology tests conducted as part of the assessment/ investigation process. Based on their retrospective review of available information, DAWN reporters are asked to identify cases in which the ED visit or death was induced by or related to drug abuse.

For the purposes of DAWN, the term "drug abuse" applies if the following conditions are met:

(1) The case involved at least one of the following:

- Use of an illegal drug;
- Use of a legal drug contrary to directions; or
- Inhalation of a nonpharmaceutical substance

and

(2) The substance was used for one of the following reasons:

- Because of drug dependence,
- To commit suicide (or attempt to commit suicide),
- For recreational purposes, or
- To achieve other psychic effects.

For each reportable case, the DAWN reporter provides demographic information on the person involved and identifies the abused drug(s) noted in the chart. Route of administration is also collected for each drug reported. For ED episodes, information about the reason for the

ED visit, the reason for using the substance, the form and source of the substance, and the patient's disposition are also collected. For ME/C cases, reporters record whether the case was determined to be drug-induced or drug-related, the manner of death, as well as information available for determining the reportability of the case (e.g., autopsy results, toxicology reports, death investigation notes, etc.).

For ED episodes, up to four drugs may be reported; for ME/C cases, up to six drugs may be reported. Alcohol involvement is reported only for cases meeting the above criteria (i.e., cases involving only alcohol and no other drug are not reportable). Each drug reported for a given case is called a "mention." Because each case may have multiple drug mentions, the number of mentions always exceeds the total number of DAWN cases.

DAWN data are notable for the richness of detail they provide relative to other available data systems. Other data systems include the following:

- National Hospital Ambulatory Medical Care Survey (NHAMCS), operated by the National Center for Health Statistics, which collects data on ED and hospital outpatient visits;

- Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS), which collects data on injuries treated in EDs, some of which are drug-related; and

- Mortality data from the National Vital Statistics System, which include cause-of-death data as documented on death certificates.

Both the DAWN ED and ME data gather very specific drug information at a level of detail not available from other sources, which tend to rely on International Classification of Disease (9^{th} or 10^{th} revision [ICD-9/10]) codes to identify drug-related cases. ICD-9/10 codes have only a few specific drug codes (e.g., for heroin, cocaine, benzodiazepines) and relegate all others to a general "not otherwise classified" category. Analysts interested in obtaining data on a specific drug outside these categories (e.g., Ketamine) cannot do so with other data systems. Moreover, there are variations in the ways in which ICD-9/10 codes are assigned. In EDs, ICD-9-CM codes are often assigned as part of the billing function; constraints on insurance coverage for drug-related cases may affect the extent to which drug-related ICD-9-CM codes are actually assigned to cases that could be otherwise coded. Vital statistics mortality data, which are coded from death certificates (which are themselves a summary of the decedent's case file), may assign ICD-10 codes to the underlying cause of death, missing the contributory effects of drug abuse.

It is the richness of the DAWN drug vocabulary that makes the system of unique and important value to a wide range of agencies and organizations concerned with drug abuse epidemiology, prevention, treatment, and control. In the next section, the primary users and uses of DAWN data are reviewed. Throughout the redesign process, these constituents and their data needs were a primary concern, and recommendations on revisions to DAWN carefully considered the likely impact on these audiences.

Users and Uses of DAWN

Development of an alternative design for DAWN began with a thorough assessment of the current and potential users of DAWN and the applications they make, or desire to make, of the data. This assessment of DAWN's utility covered a broad range of topics, including the following:

- Exploration of the specific applications made of DAWN;
- Local area needs for data on drug abuse trends and consequences;
- DAWN's ability to function as an early warning system and specific design features that inhibit, or would facilitate, this application;
- Relative sophistication of DAWN's users in analyzing, interpreting, and explaining the data;
- Degree to which DAWN suggests trends similar to other data systems;
- Value of the current set of oversampled metropolitan areas;
- Need to reduce, change, or add items in the data set;
- Importance of timely feedback to assist drug enforcement, prevention, and treatment efforts, and definitions of "timely" data;
- Appropriateness of hospital EDs and ME/Cs offices as data collection sites;
- Other strengths and weaknesses of the data system as it is currently designed; and
- Alternative data sources available to various constituent groups.

These topics were discussed with groups known to be current users of DAWN. In semi-structured interviews, representatives from DEA, FDA, and ONDCP provided information about their uses of the data and suggestions for an alternative design. Second, input was obtained from NIDA's Community Epidemiology Work Group (CEWG) through an internet-based discussion forum augmented with telephone conversations. The CEWG relies on DAWN as one of several sources of data on drug trends in the Nation's major metropolitan areas. In addition, an extensive review of the published academic literature was conducted to learn more about the uses made of DAWN by other drug abuse researchers.

To gather information from potential users of DAWN, one focus group was conducted in each of five different cities. Sharing the perception of the 1997 OAS review panel, it was assumed that DAWN's potential was greatly under-realized at the local level, and that community-based researchers outside of the CEWG would be comparatively less familiar with DAWN. This broad group – including health care providers, substance abuse treatment providers, law enforcement officials, and prevention agencies – was expected to comprise "potential" users of DAWN. The purpose of these focus groups was to ascertain their needs for data on drug abuse, and the degree to which DAWN could (in its current or future form) fulfill those needs.

Through this constituent analysis, seven major applications of the DAWN data were identified:

- Drug scheduling and drug labeling decisions by DEA and FDA;
- Indicating the extent of the nation's drug problem (primarily for ONDCP);
- Assessing the effectiveness of local anti-drug efforts;
- Guiding resource allocation decisions (for law enforcement, interdiction, treatment, and prevention services);
- Surveillance of local area drug trends;
- Documentation of historical drug trends; and
- Source data for academic research on drug abuse.

By focusing on DAWN's inability to generate substance abuse prevalence data, or its inadequacy in serving as an early warning system, critics of DAWN have overlooked many of the potential applications of the system that make it valuable, in many unique ways, to a wide variety of constituents.

With these audiences and their data needs in mind, the strengths of DAWN were then identified, and design recommendations were formulated in such a way as to protect and improve upon these factors. In addition, weaknesses in the system were also identified, and design recommendations considered whether improvements could be effected or certain features should be discontinued. Finally, to the extent that DAWN data are used inappropriately, recommendations were made for more and better education of DAWN's users. The following sections summarize key design recommendations that are responsive to the needs of DAWN's current and potential users, while recognizing the limitations inherent in any single data system.

How can DAWN be made more useful?

This was the first major question posed to the redesign team. Given the audiences for DAWN, the uses currently made of the system, and interest expressed in new applications for DAWN, the ED and ME components were examined closely to identify changes that might be made to enhance their utility. Because the two components have substantially different audiences and are used for different purposes, each component was examined separately and is addressed separately in the sections that follow.

KEY ISSUES: EMERGENCY DEPARTMENT COMPONENT

Should DAWN continue?

The 1997 OAS review panel was convened to address one major question: Should DAWN continue? The panel discussed at length the problems with DAWN but also affirmed the value of the system. The panel suggested several changes that might make the system more useful

and recommended further investigation of local-area applications of the DAWN data. Similarly, the redesign team's constituent analysis found considerable support for DAWN despite much criticism. Persons with an ongoing need for information on drug trends made it clear that DAWN has substantial potential and should continue. The development of recommendations for design changes was mindful of the specific uses that these constituencies will be making of the data provided by DAWN.

Where should DAWN be collecting data?

The redesign team addressed two general issues about where DAWN should be collecting data. The first issue focused on the units of analysis – that is, whether EDs continue to be appropriate settings for collection of data on drug-related morbidity, and whether expansion to other health care settings is warranted. The second issue focused on the geographic locations for which DAWN provides estimates, and whether and how the system's geographic coverage might be expanded. This section briefly discusses each of those issues in turn. Because these two issues are critical to the proposed design, more detail is provided about each in separate chapters within this report.

Emergency Departments and Health System Change

Participants in the 1997 OAS review panel raised questions about the impact of health system change on DAWN. Specifically, participants were concerned that changes in managed care and other features of the U.S. healthcare system have systematically affected the population seen in EDs, thereby compromising the validity of DAWN as an indicator system. The major question stemming from this discussion was whether data collection for DAWN should be expanded to include other health care settings outside of EDs, such as urgent care facilities.

A systematic review of the research literature, secondary analyses of available data, discussions with emergency physicians, and focus groups with medical personnel in four cities were conducted. The redesign team found that although the health system has changed substantially over the past 30 years, EDs continue to be the most important settings for systematic identification of persons whose health is significantly compromised by drugs and alcohol. Although recent changes in healthcare delivery have resulted in some "leakage" of less urgent drug-related cases from EDs, other changes have resulted in EDs being "flooded" with less urgent drug-related cases. The validity of DAWN does not appear to have been fundamentally undermined by these changes, but the problem is extremely difficult to assess. Physicians argued that expansion of DAWN to urgent care centers, primary care settings, or other non-ED facilities would yield few additional cases (and little useful knowledge) relative to the increased costs of data collection. Moreover, any expansion beyond EDs would need to be tailored to the specific circumstances of each community, as health system change and its effects have been highly localized.

To summarize, the available evidence suggests that the most urgent substance-related health problems are still seen in EDs, and this pattern appears to be relatively impervious to the effects of health system change. Less urgent substance-related conditions are treated in a variety of settings in addition to EDs, but the number and characteristics of these vary across communities and over time, making data collection there infeasible and interpretation of data problematic. Based on these findings, it was recommended that DAWN continue to collect data

on drug-related morbidity from EDs only. Detailed information on the redesign team's assessment of this issue is provided in Chapter 2, *Assessing the Impact of Health System Change on DAWN*.

Expanding DAWN's Geographic Coverage

In 2001, about 470 EDs reported data to DAWN. Data from these facilities are used to generate estimates of the number of drug-related ED visits in 21 major metropolitan areas as well as the coterminous United States. The redesign team's constituent analysis indicated that both national and subnational (metropolitan area) estimates are desirable and useful. The specific metropolitan statistical areas (MSAs) currently included in DAWN are largely an artifact of the system's history, and these areas do not reflect the current distribution of the nation's population. Precision of the DAWN estimates varies considerably across MSAs and the national panel, and better and more consistent precision is desired. Precision requirements, in turn, drive the estimated sample size requirements.

After considering many options and their ability to serve DAWN's current and potential audiences, the redesign team recommended that DAWN be expanded to include 48 oversampled metropolitan areas and to generate reasonably precise estimates for the entire nation. Because there is significant demand for metropolitan area estimates in 20 of the 21 current DAWN MSAs, it was recommended that all of the current areas be retained in the new design. Additionally, it was believed that the addition of more metropolitan areas would serve the needs of an even broader audience. Thus, the redesign team recommended that DAWN include the 5 most populous metropolitan areas in each of the nine Census divisions, plus all 21 of the current MSAs (see Table 1-1). This resulted in a total of 48 metropolitan areas. The proposed design adds many of the nation's largest MSAs to DAWN and provides some coverage of the less populated census divisions. As an added benefit, increasing the number of metropolitan areas means that proportionally fewer of the EDs in the sample will be located in the national panel (i.e., that portion of the country outside of the oversampled MSAs).

The estimated total sample size for the proposed design is approximately 950 EDs. The proposed sample design improves significantly the relative standard errors for estimates of total DAWN episodes and the major drugs of abuse, which should result in analysts having more confidence in the data. At the same time, the proposed sample design permits calculation of estimates for the entire nation, not just the coterminous United States, which should help with interpretation and comparison of results from DAWN. Specific details on the recommended design and factors influencing this recommendation are provided in Chapter 3, *Development of a New Sample Design for DAWN*.

Table 1-1. Metropolitan Areas in Proposed Sample Redesign

Census Division	Metropolitan Statistical Areas	
NEW ENGLAND	*Boston, MA	Providence, RI
	New Haven, CT	Springfield, MA
	Hartford, CT	
MIDDLE ATLANTIC	*New York, NY	Pittsburgh, PA
	*Philadelphia, PA	*Newark, NJ
	Nassau-Suffolk, NY	*Buffalo, NY
EAST NORTH CENTRAL	*Chicago, IL	Cincinnati, OH
	*Detroit, MI	Indianapolis, IN
	Cleveland, OH	
WEST NORTH CENTRAL	*Minneapolis-St. Paul, MN	Omaha, NE
	*St. Louis, MO	Wichita, KS
	Kansas City, MO	
SOUTH ATLANTIC	*Washington, DC	Tampa-St. Petersburg, FL
	*Atlanta, GA	*Miami, FL
	*Baltimore, MD	
EAST SOUTH CENTRAL	Nashville, TN	Knoxville, TN
	Louisville, KY	Mobile, AL
	Birmingham, AL	
WEST SOUTH CENTRAL	Houston, TX	San Antonio, TX
	*Dallas, TX	*New Orleans, LA
	Fort Worth, TX	
MOUNTAIN	*Phoenix, AZ	Salt Lake City, UT
	*Denver, CO	Tucson, AZ
	Las Vegas, NV	
PACIFIC	*Los Angeles, CA	Oakland, CA
	Riverside-San Bernardino, CA	*Seattle, WA
	*San Diego, CA	*San Francisco, CA
	Orange County, CA	

* Area is included in the current design.

Is DAWN asking the right questions?

The redesign team also was asked to consider whether DAWN was collecting appropriate information about drug-related ED visits, given the uses of the data by key constituent groups. Addressing this question called for a reconsideration of the DAWN "case definition" (the criteria with which reportable cases are identified) and data elements (the specific information recorded about each case on the DAWN report form). It was clear from the constituent analysis and review of published literature that the DAWN case definition introduces considerable confusion for data analysts, and some of the existing variables lend themselves to misinterpretation as well. In addition, it was both unfortunate and ironic that DAWN uses ED records as its data source, but collects no information about the medical conditions for which patients seek emergency care. This section provides a brief summary of the key recommended changes.

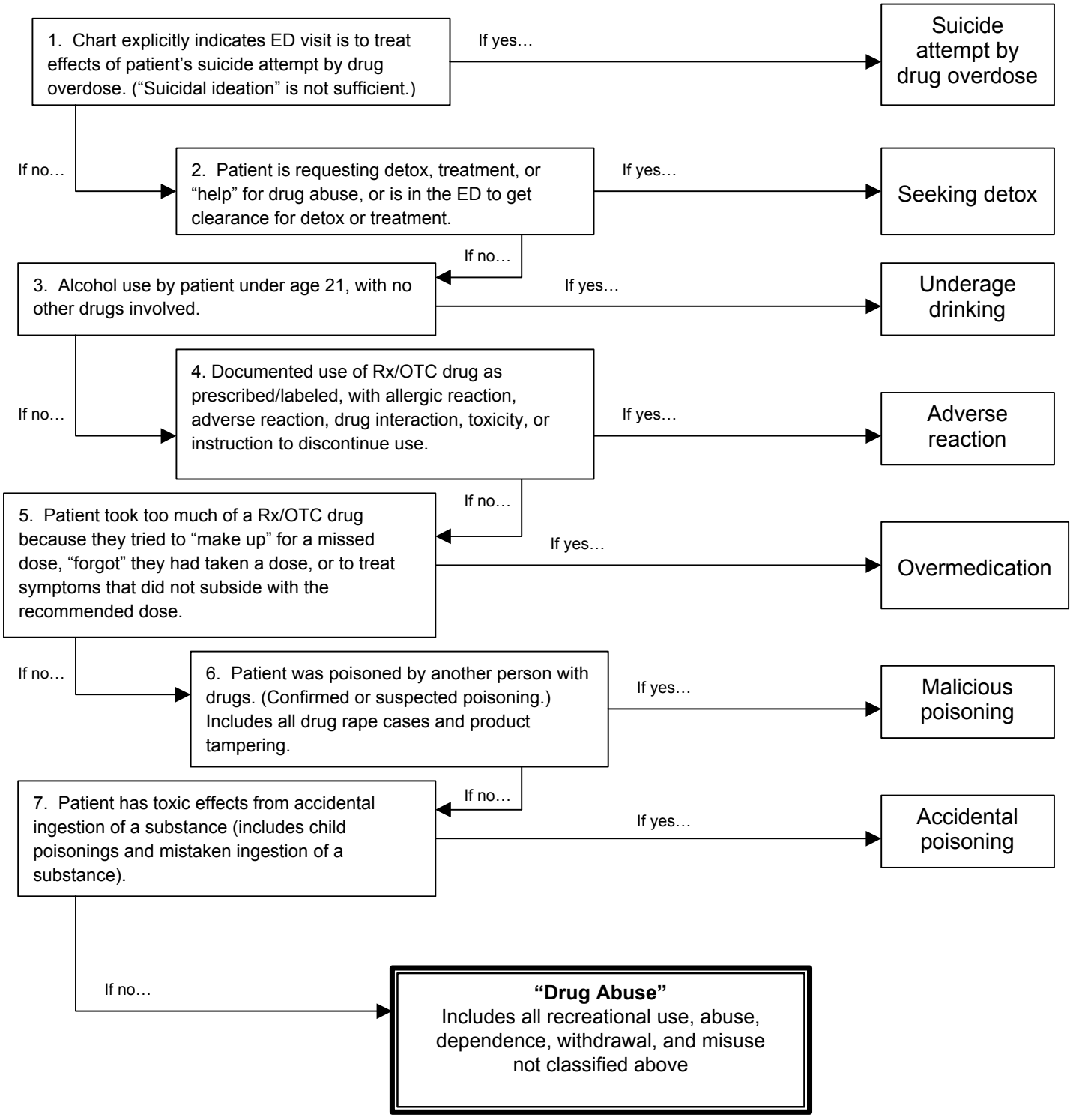
Case Definition

Briefly stated, the current DAWN case definition attempts to include only those ED patients who intended to abuse a substance. While there are multiple criteria for determining reportability, "intent to abuse" is the most problematic, because ED records rarely include explicit documentation of intent. Emergency care professionals are concerned with providing expedient treatment of a patient's injury, illness, or symptoms. Identification and documentation of the circumstances surrounding the injury or illness are not high priority activities. DAWN data collectors must often infer "intent" when reviewing patient charts. In practice, any use of an illicit drug is presumed to be with intent to abuse, and use of prescription and over-the-counter drugs is reportable if the ED record indicates suicidal gestures, dependence, recreational use, or use contrary to directions. Because case identification requires reporters to make inferences from incomplete documentation, the current case definition is applied inconsistently.

The current case definition also excludes certain classes of drug-related ED visits that are of interest to key constituent groups. ED visits related to alcohol (in the absence of other drugs) are not currently reportable. Likewise, victims of drug-facilitated assaults are not reportable to DAWN, because the victims did not intend to abuse the drug that led to their ED visits. In addition, a significant number of individuals are treated each year in EDs for adverse reactions to prescription or over-the-counter drugs taken according to direction. For post-market surveillance, both FDA and pharmaceutical manufacturers would benefit from including these cases in DAWN.

The redesign team proposed and tested a revised case definition, which sought to "cast a broad net" and collect information on a wide variety of drug-related ED visits. That "broad net" includes all ED visits for which documentation in the patient's presenting complaint, assessment, or diagnosis indicates that the condition being treated was related to the ingestion of a substance. Illicit, prescription, and over-the-counter drugs are included, as are inhaled nonpharmaceuticals. The types of cases included and a proposed system for sorting them are depicted in Figure 1-1. This approach requires minimal decision-making on the part of reporters. This should reduce the learning curve for new reporters and reduce inter-reporter variability in applying the definition. The breadth of the definition used in conjunction with new data elements will increase end-users' flexibility in analyzing the data. Finally, the proposed expanded definition would continue to capture core drug abuse cases of interest to current DAWN users, while also capturing adverse reactions and other toxic effects, allowing DAWN to expand its constituent base.

Figure 1-1. Type of Case Classification. What type of case is it? Using information documented in the patient's chart, reporters should classify the case as the first type for which it meets the specified criteria.



Underage Drinking

Another important change to the case definition is the recommendation to collect information on ED visits related to underage drinking. Many of DAWN's current and potential constituents expressed an interest in obtaining data on "alcohol only" cases from DAWN. Although the epidemiology of alcohol problems is comparatively well-studied and substantial data are available, ED data are not reported by any other system. At present, DAWN is the only drug-related national data collection system that explicitly defines alcohol as a non-reportable substance (in effect, a non-drug). However, under any definition, alcohol is an illegal substance for persons under age 21.

Interviews with health care providers as part of the redesign team's health system study indicated that among all substance abuse cases, alcohol intoxication cases are most susceptible to nonrandom "leakage" from EDs due to local policies for dealing with public inebriates. However, youth (under age 21) are not the targets of these policies; therefore, collection of "alcohol only" cases for persons under 21 is unlikely to introduce unacceptable levels of noise into the DAWN data.

Field tests in a number of hospitals, along with secondary analyses of data from NEISS, suggested that the collection of *all* alcohol-only cases would substantially increase the volume of cases reported to DAWN, perhaps as much as tripling the number of cases reported. An across-the-board addition of these cases, along with other proposed redesign changes, would exceed OAS's available resources. However, these same data suggest that the volume of underage drinking cases will be minimal but sufficient to address the issue to the satisfaction of most constituencies.

Data Elements

Since its inception in 1972, DAWN has collected information on drug-related ED visits, but it has collected virtually no information about the medical conditions for which patients seek care. At the same time, it has attempted to collect some information that ED records are ill-suited to provide. The redesign team's recommendations for changes to the information collected by DAWN considered the needs of DAWN's users as well as the constraints imposed by relying on second-hand review of medical charts. Key recommendations are summarized here and in Table 1-2.

DAWN was initially implemented by the DEA, a law enforcement agency. Some of the data elements collected in DAWN reflect a law enforcement application of the data. For example, DAWN reporters have been asked to determine the form in which the patient *acquired* the drug (not the form in which it was consumed), as well as the source of the drug (e.g., street buy, legal prescription, unauthorized procurement). These pieces of information are generally not recorded in ED charts, because the information is irrelevant to emergency care staff in their diagnosis and treatment of the patient's presenting complaint. In the final data file, the majority of cases are missing this information. In addition, reporters may be tempted to assume the form or source of certain drugs and complete the item based on assumption rather than documented evidence. Because this information cannot be collected reliably, and because the amount of missing information creates problems in interpretation of the data, the redesign team recommended that DAWN discontinue collection of these items.

DAWN also collects information on route of administration of a drug (e.g., injection, oral, inhalation). Like "form" and "source," this information is not reliably documented. Better information on trends in route of administration is available from treatment data sets such as Treatment Episode Data Set (TEDS), because drug treatment providers routinely ask about and document this information. However, this particular item could be of value to DAWN for correctly classifying inhaled substances. The redesign team recommended that nonpharmaceuticals be reportable to DAWN only if there is documentation that they were inhaled. Collection of limited route of administration data will help analysts ensure that those drugs are correctly classified.

The redesign team also recommended the collection of a number of data elements to better describe the medical condition of the patient being treated in the ED. These include some information about the patient's presenting complaint, the nature of the drug involvement in the presenting condition, the diagnosis(es), and more detailed information on the patient's discharge status. Finally, collection of a case description through an open-text field was also recommended. This information could assist in documenting the circumstances of the case, allowing data collection staff to confirm whether it was in fact reportable to DAWN, and possibly helping analysts identify emerging patterns in cases involving new drugs or new drug combinations.

Case Identification

The redesign team was also asked to look at the process by which cases are screened for reportability to DAWN. Currently, three methods are used. The preferable method is called "100% chart review," in which reporters attempt to review all of the ED charts to identify DAWN cases. As of May 2001, just over 50 percent of the participating hospitals were using this method. Other facilities have elected to use a different method, either because the reporter cannot get access to all of the charts or because there are so many charts that the reporter cannot review them all. About one-third of the participating hospitals use a "log screen" method, in which the reporter reviews the presenting complaints recorded in the ED case log to identify patients with a high likelihood of being reportable to DAWN. The charts for those likely cases are then reviewed. The remaining hospitals use an "ICD-9-CM screen" method, in which a hospital staff member provides output from a data file containing the ICD-9-CM codes assigned to each visit, and the DAWN reporter reviews those to identify patients with a high likelihood of being reportable to DAWN. The charts for only those "likely" cases are then reviewed.

Although these alternative case identification methods may be helpful in reducing the burden on reporters, they have not been systematically assessed. Because each hospital sees a somewhat different patient population, and because each facility has different documentation and record-keeping styles, the log and ICD-9-CM screens must be adapted to each individual hospital. Unfortunately, this means that there may be substantial variability across facilities in the sensitivity and specificity of the methods used. It is unknown how many DAWN-reportable cases are missed by these screens.

Table 1-2. Recommended Data Elements for DAWN (ED Component)

Data Element	Recommended change	Explanation
Provider number		A unique hospital identifier, for SAMHSA use only.
Cross-reference		A record identifier for reporter use only.
Date and time of ED Visit	Month of visit	For SAMHSA use only. Date/time of visit, when combined with other case characteristics, could potentially identify an individual. Month of visit is the smallest unit needed to process and report DAWN data.
Age	Remove age limits	DAWN should collect data for patients of all ages. To protect individual identities, age categories should be collapsed for all patients under age 6 and over age 85.
Sex		
Ethnicity/race	White/Black/Hispanic/Other	Reporters have substantial difficulty with the ethnicity category (not understanding it, or the information is not available). DAWN should revert to the 4-category combined race/ethnicity variable.
Patient's home ZIP Code	Living arrangements (fixed address, no fixed address, not documented)	ZIP Code data are often unavailable, or require reporters to access separate databases. The data are not available for public use, and can potentially be used to identify individual patients. Because policies toward the homeless can have a substantial effect on ED case volume, the redesign team recommended changing this variable to focus on whether or not patients are homeless.
Case description	Open-text field in which reporters record information about the presenting complaint and assessment.	This is a new data element. For SAMHSA use only.
Reason for taking substances	Do not collect.	Eliminate from current form. Replace with "Type of case" (see below).
Type of case	Eight categories, described in flow chart above.	This is a new data element.
Reason for present contact	Do not collect.	Eliminate from current form. Replace with "Presenting complaint" (see below).
Presenting complaint or condition	Categories to identify the type of medical condition for which the patient sought treatment in the ED. To be developed.	This is a new data element. An initial list of conditions could be specified, but the data collection team should monitor information in the "case description" variable over the first several months of data collection to develop and refine a comprehensive and analytically useful list.
Diagnosis(es)	Text field; record all listed diagnoses.	This is a new data element. Diagnoses could be categorized as needed to meet specific research questions.
Alcohol involved?	None	To be retained.

Table 1-2. Recommended Data Elements for DAWN (ED Component) (continued)

Data Element	Recommended change	Explanation
Drug(s) involved – list all substances separately	Allow reporters to list up to 6 substances plus alcohol (currently 4 + alcohol).	Addition of Rx/OTC reactions may necessitate these additional fields.
Form in which drug was acquired	Do not collect.	
Route of administration	Change to include only four categories: injected, oral, inhaled/sniffed/snorted/smoked, information not documented.	For SAMHSA use only. This data element will be used only to facilitate correct classification of nonpharmaceuticals (i.e., inhalants), as well as to differentiate prescription and over-the-counter medicines available in different forms (e.g., antihistamine pills versus nasal sprays).
Source of substance	Do not collect.	
Disposition	Revise to include more specific categories: (a) Treated and released (discharged home, transferred, sent to drug treatment/detox, released to police custody); (b) Admitted (ICU/critical care, medical/surgery, psychiatric unit, chemical dependency/detox unit); (c) Left against medical advice; (d) Died; (e) Information not documented	In recent years, about 48% of DAWN cases were "treated and released," while another 48% were "admitted." More information is needed to differentiate patients in these categories. In particular, more information is needed to indicate when the ED functions as a route of entry into the substance abuse treatment system.
Coded remarks	Do not collect.	
Urgency/acuity (initially proposed)	Do not collect.	The redesign team's field test indicated that because of substantial variation in ED triage and documentation procedures, these data cannot be collected using a standard set of categories.
Insurance coverage (initially proposed)	Do not collect.	The redesign team's field test indicated that this information is not readily available to DAWN reporters.

The redesign team was asked to look at the application of the log and ICD-9-CM screens in two hospitals. The goal of this limited study was to assess the sensitivity and specificity of each screen under the current case definition versus the proposed "broad net" case definition. In other words, the redesign team was asked to assess what proportion of reportable cases were correctly identified by each screening method, what proportion of non-reportable cases were correctly ruled out by each method, and whether the rate of false positives and false negatives was substantially different in the current versus proposed case definitions. The concern was that broadening the case definition would require adding so many additional presenting complaints or diagnoses to the screens that the screens themselves would not be specific enough to be useful. The redesign team was not asked to perform a system-wide assessment of these screens, nor to assess the variability across hospitals in the application of these screens.

The screening method study yielded three major findings. First, both the log screen and the ICD-9-CM screen, using a set of complaints/codes customized for the particular ED, successfully identified about 70 percent of the reportable DAWN cases. This means that, assuming the study period was representative of the hospital's usual case flow, reporters in either facility would miss about 30 percent of all reportable cases by relying exclusively on the screening method. Second, the sensitivity of the screening method was not appreciably different between the current case definition and the proposed "broad net" definition. The specificity of the log screen became marginally worse with the new case definition (because so many more presenting complaints need to be added to the screen), while the specificity of the ICD-9-CM screen was marginally better with the new case definition (because ICD-9-CM codes exist for the newly-added adverse reactions and drug toxicity cases). In any event, alteration of the case definition seems to pose less of a problem than the relatively low underlying sensitivity of the screens to drug abuse cases.

Third, it is unlikely that the true sensitivity of either of these two methods can be reliably tested, given the real-world conditions under which medical records are created, used, and stored. Even in the 100 percent chart review hospitals, it is unknown how many patient charts are moved out of the ED before the reporter can obtain access to them. A fundamental problem – and a reality of collecting data in emergency departments – is that different hospitals manage medical records differently. Data collection for DAWN must be cognizant of inter-hospital variation in medical record-keeping systems. Systematic differences between hospitals must be identified and documented. The degree of access to the population of medical records must be quantified before any specific data collection strategies are developed. As the new hospital sample is implemented, some norms may need to be established so that OAS can make informed decisions about the level of medical record access required for a hospital to participate in DAWN. Hospitals unable to provide access to the required proportion of charts could be replaced with facilities better suited to DAWN participation. Direct review of all available medical records must be the gold standard to which DAWN reporters are held. Screening methods may lighten reporters' workloads, but they cannot ensure complete and consistent case identification.

KEY ISSUES: MEDICAL EXAMINER COMPONENT

Should DAWN-ME continue?

At the outset of the redesign project, there was some skepticism as to whether the DAWN-ME component was sufficiently useful to be worth saving. Little was known about the audience

for the ME data, OAS itself lacked confidence in the system, and there was some concern that the investment required to repair the system would be prohibitive. The initial constituent analysis activities, which focused on the ED component, identified only minimal use of the DAWN-ME data. Still, OAS is required by law to collect data on drug-related deaths. The redesign team was asked to consider whether this mandate could be effectively fulfilled by the use of an alternative data source, and whether there exists sufficient demand to warrant continuation of the DAWN-ME component in some revised form.

A more focused review of the users and uses of drug-related mortality data revealed the importance of DAWN as a surveillance system and suggested its unrealized potential. The redesign team spoke with a number of participating ME/Cs, exhibited DAWN booths at the 2001 annual meetings of the American Academy of Forensic Sciences (AAFS) and the National Association of Medical Examiners (NAME), and reviewed published analyses of drug-related mortality data. They also reviewed other major data collection efforts that provide information on drug-related deaths, to see whether any of these might be suitable substitutes for DAWN. Key findings from those activities are briefly summarized here.

The DAWN-ME data are a unique source of information on drug-related mortality in the United States. DAWN is the only large-scale surveillance system that collects data directly from MEs and coroners, including detailed information on all illicit or abused substances and related metabolites detected in the decedent. This differs from other data sources, such as national vital statistics data, which list only a few drugs or drug categories and are limited by the short list of specific drugs available when using ICD-9 or ICD-10 codes. Moreover, national vital statistics data rely on death certificates, which are not reliably updated with information obtained by ME/Cs after the completion of a full death investigation (which usually includes toxicology test results).

DAWN is unique in the level of drug detail it collects and reports. In addition, it is the only system of its type to provide data for specific metropolitan areas, and it can provide data at the jurisdiction level. Moreover, data on drug-related deaths provide an important complement to the ED data, as they show another indication of severity or danger associated with certain drugs. Given the unique features of DAWN-ME data, it was concluded that with some changes to improve DAWN's timeliness and dissemination methods, new audiences might be reached, and new applications might be realized.

Discussions with ME/Cs revealed substantial interest in the type of information DAWN provides, particularly at the jurisdiction level. ME/Cs noted that there is no other data set that provides the type of information that DAWN can offer. DAWN provides ME/Cs with information on drug-related deaths in "their own backyards" – information that is needed for effective surveillance of local drug trends. Moreover, MEs have indicated a readiness for electronic data collection, with nearly half of the current DAWN participants submitting data on-line as of July 2001. Most of the MEs who were contacted by the redesign team viewed participation in projects such as DAWN to be part of their professional obligation, and, except for access to their data, few other incentives were mentioned as being needed to encourage participation. In fact, several MEs approached staff at the DAWN exhibit booths and offered to begin submitting data to DAWN immediately, for no payment other than defraying staff costs to process the data. Based on input from ME/Cs themselves, it was clear that the DAWN-ME data held great potential, which could be met by providing more jurisdiction-specific feedback and eventual database-querying capabilities.

Access to "real-time" data would provide practical advantages for participating ME/Cs. Although identification of new drugs and emerging trends is important for public health surveillance purposes, ME/Cs also need this information to more efficiently and effectively conduct death investigations. ME/Cs often request standard toxicology panels – that is, they have a set list of drugs for which they routinely test. As a result, these standard panels are not useful for identifying new drugs of abuse. Because of the expense associated with certain drug tests, and the time lag involved when more tests are ordered, ME/Cs generally will not order an additional test unless they have reason to suspect a particular drug was involved in the death. With timely feedback of data to participating ME/Cs, DAWN can provide information with which to assess trends in specific drugs in the ME's jurisdiction and the surrounding areas – that is, it can identify an increase in deaths associated with a given drug. Likewise, DAWN can provide basic descriptive characteristics of deaths in which a given drug was involved. With this information, ME/Cs can make more informed decisions about when to order toxicology tests for drugs that are not included in their standard panels.

Where should DAWN-ME be collecting data?

A review of the published literature showed common use of vital statistics data (at the state or national level) by researchers interested in obtaining population-based rates of drug mortality, or to monitor year-to-year trends in deaths associated with specific drugs. Those researchers seemed well aware of the limitations of vital statistics data, and drew appropriate conclusions based on available information. Given their interests (population-based rates, national trends, "drugs of abuse" as a general analytic category) and their relative analytic sophistication, most of these researchers obtain sufficient information from vital statistics data. A redesign of DAWN to provide national estimates would largely duplicate existing systems.

The redesign team's constituent analysis also discouraged the development of national estimates. With the exception of ONDCP, there was little or no support for a redesign of the ME component to generate national estimates for DAWN. Rather, there was substantial interest in local data (county, jurisdiction and metro area), as well as interest in expanding the number of metro areas reporting to DAWN-ME.

There are also technical limitations to the development of national estimates from DAWN. Although not insurmountable, these issues would introduce unknown degrees of bias into the resulting estimates. Of particular concern, developing estimates from ME/C data assumes consistency in the source of data across jurisdictions. There are more than 2,000 ME/C jurisdictions nationwide, and there are substantial differences between states (and among jurisdictions within states) in the type of cases accepted for review, the review processes used (e.g., toxicology test protocols), and the qualifications/training of staff involved. In addition, without polling each jurisdiction, the total number of cases processed by each office each year is unknown; such information is crucial to developing a sampling strategy. These issues would introduce unavoidable measurement and sampling error into the estimates developed. While these problems might be resolved through a lengthy and systematic review of the national death investigation system, it remains the case that the key users of data on drug-related mortality have not shown sufficient interest in national estimates from DAWN to warrant the effort required to produce them.

Instead, considering user needs and available resources, the redesign team recommended that DAWN expand its coverage of ME/C jurisdictions within the current 21 MSAs, prioritizing the recruitment of the largest jurisdictions not currently participating. Further, it was

recommended that as new metropolitan areas are added to the DAWN-ED component, DAWN-ME should seek participation of medical examiners and coroners in those areas as well. At present, DAWN receives data from 47 percent of the counties in the 48 proposed metropolitan areas. Those participating counties are home to 68 percent of the total population in those MSAs. Thus, although about 160 jurisdictions need to be recruited to achieve full participation in each MSA, more than two-thirds of the total target population is already covered by DAWN. With morbidity and mortality data available for selected metropolitan areas, DAWN can make a substantial contribution to a local knowledge about the most serious health outcomes associated with drug use.

Is DAWN-ME asking the right questions?

The ME component faces a different set of challenges than the ED component in terms of the application of the case definition. DAWN reporters in participating ME/C offices have access to the full case file for each decedent and can therefore make a determination about reportability based on a complete spectrum of information. Unlike ED physicians, ME/Cs must make a determination about the underlying cause of death and will indicate when a specific contributing factor (such as drug use) is involved. Because ME/Cs must make some assumptions in determining cause of death, the DAWN report form asks reporters to indicate whether drug involvement in the death was confirmed or presumed. Thus, reporter inference is minimized.

Some ME/C procedures affect the types of cases reported to DAWN. Some of these are factors that DAWN cannot change. For example, some ME/Cs do not run toxicology tests for marijuana. This may be because the tests are expensive, marijuana use is relatively common compared to other drugs, and/or because marijuana overdoses are not common causes of death. Therefore, some ME/Cs never report marijuana mentions for any of their cases. DAWN is unlikely to be able to change this practice. Other factors might be changed by providing additional training to the reporters or by better understanding the reasons for different reporting patterns. For example, some jurisdictions report only drug-induced deaths to DAWN, but never drug-related deaths. This would suggest that perhaps those reporters misunderstand DAWN's case definition and are reporting only overdose deaths. On the other hand, this may reflect different documentation practices of different ME/Cs. The reasons for these variations among jurisdictions need to be documented so that the resulting data may be appropriately interpreted.

The redesign team recommended relatively few changes to the case definition used in the DAWN-ME system, although it was proposed that the DAWN-ME case definition be changed to be consistent with the proposed ED case definition. Specifically, the new case definition would collect all drug-involved deaths (both drug-induced and drug-related), including deaths causally or indirectly related to prescription or over-the-counter drugs, whether or not the decedent had intentionally abused them. This change will increase the utility of DAWN for other agencies and audiences and should reduce the variability in reporting across jurisdictions by minimizing reliance on reporter inference regarding the decedent's intent. As with the ED component, alcohol-involved deaths would be reportable for decedents under age 21. Systematic differences across jurisdictions in the documentation and processing of deaths should be identified and documented, so that appropriate conclusions may be drawn from the resulting data.

Mindful of the desired uses of these data, the proposed changes to the DAWN-ME case definition will ensure that DAWN is asking the right questions. Additional changes are needed

to ensure that DAWN is disseminating the right answers. Until 2001, the published reports presented the DAWN-ME data in substantially the same format as the DAWN-ED reports. Unfortunately, by providing reports that look similar, some users assume that similar conclusions can be drawn from the ED and ME data. That is, they assume that the system totals shown in the DAWN-ME tables represent national estimates, and they assume that metropolitan area totals represent MSA estimates. Neither is the case. The published reports provide aggregated data, but the participating jurisdictions are not the result of a statistical sample, and coverage is inconsistent across metropolitan areas. To minimize misinterpretation of the data, OAS redesigned the DAWN-ME reports beginning with the 2001 publication (2000 data). The new design focuses on jurisdiction and metropolitan area data, prominently shows the specific jurisdictions that are and are not participating in DAWN, spotlights population centers within metropolitan areas, and eliminates tables that aggregate system-wide data.

At the DAWN exhibit booths at the AAFS and NAME meetings, ME/Cs expressed considerable interest in jurisdiction-level data. Data aggregated to the metropolitan area level only introduced questions about how one jurisdiction compared to another within the same MSA. The MSA is a concept defined by the Office of Management and Budget (OMB) for purposes not relevant to MEs, whose jurisdictions are most often defined by county boundaries. ME/Cs will find more value in, and use for, reports that disaggregate data to the jurisdiction level. Unlike the ED component, DAWN-ME has the capacity to provide geographically meaningful sub-MSA data and should take advantage of this capability. If data are provided at the smallest geographic unit of analysis, users can choose how to aggregate data to meet their particular needs.

CROSS-CUTTING ISSUES

How can the quality and timeliness of DAWN data collection and reporting be improved?

Data quality and timeliness are issues that cut across both the ED and ME components, and nearly all topics considered by the redesign team. This section summarizes key findings and recommendations in two main areas: data collection and processing, and dissemination methods.

Data Collection and Processing

The redesign team was asked to examine various options for electronic data collection in DAWN. At present, DAWN-ED data are collected by reporters who examine ED patient charts. The reporters identify the patient visits that meet the criteria to be reportable to DAWN, extract the information required by DAWN, write this information onto paper report forms, and ship these forms to a central office, where the information is keyed into a computer database. Thus, data entry and transmittal in DAWN-ED are largely manual processes involving a large number of paper forms. As with any manual process, DAWN data collection can be cumbersome, slow, and error-prone.

DAWN-ED reporters will require electronic data collection strategies that allow them mobility within their work environments. Reporters often must access different data sources in different physical locations and cannot always complete a DAWN report form while sitting in one place. In this sense, paper forms are well-suited for some reporters because they can readily be carried from place to place. Computerized approaches must be mindful of this need for

mobility, as well as the fact that some reporters do not have designated workstations, secure storage areas, access to personal computers (or desks on which to put them), or access to telephone or Internet connections.

By comparison, ME reporters pose fewer technology challenges than ED reporters. DAWN reporters in participating ME/C offices generally have access to the full case file for each decedent and do not have to assemble pieces of information from different data files in dispersed locations. The data collection contractor has developed a data collection application called eMERS (electronic Medical Examiner Reporting System), which had been deployed in about half of the participating ME offices in DAWN by mid-2001. Indications are that most reporters in the ME offices have access to a desk, and reporters in the facilities using eMERS have access to a desktop computer with an Internet connection. As of 2001, OAS has not yet had to supply a computer or an Internet account to any of the eMERS participants. Given the current state of data collection in DAWN-ME, the redesign team focused its attentions on the ED component.

Several electronic data collection options for DAWN were considered. These included a personal digital assistant (a handheld device), a data tablet (a larger handheld device with a keyboard and touchscreen), and a laptop or desktop system. The data collection contractor has developed and begun to deploy a functional Internet data collection system for EDs that was similar to the ME system; it is known as eHERS (electronic Hospital Emergency Reporting System), and had been installed in several hospitals by mid-2001. Because the development and deployment of this system occurred simultaneously with the redesign effort, the redesign team did not assess this option other than as a point of reference for stand-alone technologies. In addition, the redesign team considered the feasibility of near-term implementation of an automated electronic data interchange (EDI) process that could gather data directly from computerized ED data systems.

Although palmtop and tablet devices offer maximum portability, it was found that many of their hardware, memory, and ergonomic features were extremely limiting. A substantial challenge involved storage of DAWN's detailed drug reference vocabulary, a list that presently includes upward of 10,000 drug names. This caused both systems to slow considerably, and the long list of drugs made it easy for a user to select an incorrect entry using the stylus. Entry of a previously-unrecorded drug was equally cumbersome, and this did not bode well for the open-ended case description and diagnosis fields proposed for the revised data collection form. Because of problems such as these, further development of the palm and tablet devices was discontinued. However, it should be noted that the technology in this field is rapidly evolving. As vendors continue to improve the range of software and hardware options for handheld data recording devices, it may become more likely that a specific program can be adapted for DAWN.

An immediate solution to the portability issues that are central to ED reporters is the development of data entry software for a laptop computer. Laptops and desktops offer larger screens, permitting a preferable layout of the electronic form. Likewise, personal computers have little difficulty searching the lengthy drug list, and full-size keyboards allow for easy text entry. Data can be securely uploaded via modem to a central server. An application developed by the redesign team showed considerable promise but for various reasons could not be subjected to a rigorous field test during the performance period of the contract. Such a test is required before implementing computerized data collection in DAWN. Additionally, screen layouts for the final laptop/desktop application should be substantially similar to the Internet

application, facilitating the development of a single set of training manuals, user guides, and helpdesk functions.

Any computerized data entry system for DAWN must permit reporters to submit data on a flow basis. This is not presently the case. Instead, data are captured and batched only after the end of a predefined reporting period (typically a 7- to 10-day period), a holdover from historical paper data collection procedures. In other words, the current paper and electronic systems impose constraints on the frequency with which reporters can physically submit data. As other redesign activities have shown, real-time submission, analysis, and dissemination of DAWN data are essential to the system's ability to provide timely surveillance of emerging drug trends.

Dissemination Methods

As its name implies, DAWN was designed to provide early warning of emerging drug trends at the local and national level. The redesign team provided recommendations for statistical approaches and dissemination strategies to accomplish these objectives. They proposed the use of statistical process control (SPC) models to identify meaningful deviations from historical reporting patterns at both the facility and metropolitan area levels. SPC models can identify, but cannot explain, statistically significant deviations in reporting patterns for a given drug, group of drugs, diagnosis, or other condition. Investigation of those deviations may reveal data processing or analysis errors, important changes in a hospital's ED population, local health system changes, or other factors that might result in unusually high numbers of drug-related ED visits. Thus, an SPC approach can simultaneously serve as a quality control process, provide historical context for current data, and alert OAS to potentially important shifts in drug trends both locally and nationally.

The potential value of information provided by SPC models highlights the importance of facility feedback and broader dissemination of DAWN data. Successful implementation of the redesigned DAWN requires a comprehensive information dissemination and constituent-building strategy. This strategy must include timely feedback of data to participating facilities, whether in hard copy or online. Feedback reports might also highlight missing data to help encourage more complete or timely reporting. Feedback reports should include not only frequencies of substances reported to DAWN, but some historical and regional comparisons to help emergency care staff and ME interpret the data. Efforts must be made to identify and target the facility staff who can best make use of the information provided by DAWN.

The redesign – specifically, the implementation of a new case definition and data elements, and the eventual addition of new metropolitan areas – will require changes to the mid-year and year-end DAWN reports. In addition to implementing necessary changes to the published tables, some revisions could be made to the layout of the reports, with the goal of enhancing their appeal and utility for various end-users. A revised ME report is being developed for publication of the 2000 DAWN-ME data, and lessons learned from that process may help OAS identify important design features for the ED reports. Continued production of *The DAWN Report* will provide opportunities to disseminate brief, focused analyses of special topics.

The redesign team also recommended dissemination of information about the redesign itself, including the reasons for, and implications of, the changes being made to DAWN. Finally, the team recommended that OAS establish a presence for DAWN at the meetings of major trade associations and professional organizations, such as NAME, the American College of Emergency Physicians, the Emergency Nurses Association, and the American Public Health

Association. Activities could include exhibit booths, as well as presentations of key findings. Panel presentations on DAWN and its potential applications may help publicize the redesign, while periodic presentations of research findings can disseminate findings from DAWN while modeling appropriate uses of the data. Publications of research findings in peer-reviewed journals will further help build and strengthen DAWN's reputation among the research community.

CONCLUSION

In an effort that spanned several years, OAS and the redesign team documented the primary users of DAWN data, the potential users of a redesigned system, and the major applications that are made of the data. Recommendations were made for changes that are needed to ensure that DAWN is asking the most appropriate questions, providing clear and correct answers, and reaching the most important audiences. All design recommendations have been mindful of the way in which the data are used and of the limitations inherent in gathering data from a secondary review of medical records and case files. The goal was to suggest design features that will preserve the utility of DAWN for its current users, expand its reach to new audiences, enhance users' understanding of DAWN, and improve the quality and timeliness of the data. Implementation of a new design represents a critical step in DAWN's history, and provides numerous opportunities for OAS to realize the system's full potential.

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2. ASSESSING THE IMPACT OF HEALTH SYSTEM CHANGE ON DAWN

The Drug Abuse Warning Network (DAWN) monitors the number of drug-related admissions to emergency departments (EDs) only. Consequently, DAWN cannot be used to estimate drug abuse prevalence but can be used as one indicator of the intensity of the nation's substance abuse problem. DAWN is sensitive to a number of drug-related factors that contribute to the intensity of the substance abuse problem in the general population: the price and purity of drugs, methods of administration of a drug, dose and frequency of drug use, potency of drug combinations, and aging of the substance abuse population. It is expected that increases or decreases in these factors will result in corresponding changes in the number of DAWN ED episodes and mentions.

The DAWN redesign team was asked to investigate whether DAWN might also be sensitive to health system changes *unrelated to substance abuse*. Specifically, the 1997 Office of Applied Studies (OAS) review panel was concerned that evolving managed care practice could result in a shift in the locus of care for substance abuse away from EDs to urgent care and ambulatory care centers. A noticeable decline in ED substance abuse cases would make the interpretation of DAWN trends and patterns problematic. If health system changes significantly altered the composition of the ED patient population, then the number of cases detected by DAWN could be unrelated to underlying changes in the intensity of the drug problem. For example, increases in the number of medically uninsured could shift utilization from primary care clinics to EDs, "flooding" the ED with a poor, uninsured population; managed care practices could divert ED utilization to urgent care or primary care settings.

This chapter explores the scope and size of the effects of health system change on the ED population and DAWN counts of substance abuse cases. A literature review identifies some factors that can affect the characteristics of this population. Analyses of national data sets provide additional information about ED utilization, insurance status, and limitations associated with existing data. A qualitative study undertaken to identify local patterns in seeking help for medical conditions related to substance abuse is described. Finally, the implications for DAWN are discussed.

REVIEW OF LITERATURE

There is little empirical research that explains whether and how health care system changes over the past 3 decades have systematically affected the substance abuse population seen in the ED. Some articles attempt to characterize changes in the ED population over time. These articles are largely based on experience in single, urban EDs usually associated with an academic institution and are not generalizable to the nation as a whole. Other recent research investigates the effects of managed care on ED utilization. These two categories of articles describe four major elements of health system change that can impact ED-utilization patterns:

- Increases in the numbers of persons who are medically indigent;

- Lack of a primary care provider;
- Alternative sites of emergency and urgent care; and
- Growth of managed care.

Increases in the Number of Persons Who Are Medically Indigent

Changes in the number of medically indigent and homeless persons could increase the number of persons seeking care in EDs. The number of uninsured patients is increasing nationally. Recent estimates from the Agency for Healthcare Research and Quality (AHRQ), based on the Medical Expenditure Panel Survey (MEPS), indicate that 16.8 percent of the U.S. population had no health insurance in 1996 (Vistnes & Zuvekas, 1999), up from 12.9 percent in 1987 (U.S. Census Bureau, 1999). The ED is the solution of last resort for persons unable to pay for medical care (Millmann, 1993). The Emergency Medical Treatment and Active Labor Act (EMTALA) stipulates that all patients who present to the hospital ED should be evaluated and medically stabilized. Unlike other care sites, which may turn away persons for lack of funds, hospital EDs are mandated to treat at least minimally all persons presenting for care, regardless of the severity of the condition or the ability to pay.

In many communities, the ED may represent the only source of medical care for persons who are medically indigent or homeless. Several sources indicate that the homeless are more likely to use the ED than clinics or physician offices as a primary source of medical care (Little & Watson, 1996; Malone, 1998; O'Toole, Gibbon, Hanusa, & Fine, 1999; Rask, Williams, Parker, & McNagny, 1994). The ED provides important ancillary social services for this population (Malone, 1998). Thus, while the ED treats emergency cases that are of particular interest to public health surveillance, it also provides non-urgent care for medically uninsured persons and other populations without other access to primary care.

There is some evidence that the medically indigent and the homeless are more likely to have substance abuse problems. Survey data from the 1997 National Household Survey on Drug Abuse showed that household residents without health insurance were more than twice as likely to report past-year illicit drug use than were those who had some form of insurance coverage (Office of Applied Studies, 1999a). According to 1997 National Hospital Ambulatory Medical Core Survey (NHAMCS) data, ED visits for alcohol- and drug-related problems were more than twice as likely to be self-pay as visits for all other problems (NHAMCS public-use files). In a study of homeless adults, two-thirds of a sample of 1,563 homeless adults met criteria for chronic substance dependence (Koegel, Sullivan, Burnam, Morton, & Wenzel, 1999).

The data indicate that as more people are without health insurance, persons with substance abuse problems are more likely to be uninsured, and the number of uninsured cases treated in the ED for substance abuse will increase. These increases reflect a shift of medical utilization from primary care clinics to the ED among persons who lose their insurance. This trend could increase the number of substance abuse cases treated in the ED, in addition to any increases resulting from a larger number of cases in the community or the hazardous characteristics of drug(s) in use. On the other hand, fewer patients might be treated in the ED if primary care sites treating the uninsured are available.

Lack of a Primary Care Provider

Health system changes affecting access to primary care could affect ED utilization. A substantial number of patients use the ED as a source of primary care for the treatment of non-urgent medical conditions. African Americans and Hispanics are more likely to identify the ED as their regular source of health care (Baker, Stevens, & Brook, 1994), as are patients living in homeless shelters (Rask et al., 1994). Patients who identify the ED as their regular source of care are three times more likely to have used the ED more than once in the preceding year (Diamant, Brook, McGuigan, Fink, & Gelberg, 1998). Primary care physicians are less prevalent in poor urban neighborhoods and the urban poor lack access to primary care due to lack of transportation (Baker, Stevens, & Brook, 1991; Young, Wagner, Kellermann, Ellis, & Bouley, 1996).

Substance abusers have been identified as a group that is more likely to use the ED as a source of primary care. A study of 500 current chronic drug users in Florida revealed that one-third used a community clinic for regular health care, one-third had no usual source of care at all, and the remaining third used a hospital ED (McCoy et al., 1997). Substance abusers who have not been treated for their substance abuse disorder tend to be high utilizers of medical care, particularly of emergency and inpatient services. A substance abuse diagnosis significantly increases the risk for repeated ED use (Spooren, De Bacquer, Van Heeringen, & Jannes, 1997). Between 40 percent and 58 percent of patients making more than 10 visits to an urban ED in a year had psychiatric or substance abuse problems (Kne, Young, & Spillane, 1998; Rask, Williams, McNagny, Parker, and Baker, 1998; Spillane et al., 1997). Chronic drug users were about 30 percent more likely to seek care in EDs than either casual drug users or non-users (McGeary & French, 2000).

There is strong evidence that homeless and minority substance abusers, in particular, have traditionally used the ED as a source of primary care. Changes in the medical system that systematically redirect patients from ED to other primary care settings could have substantial impact on DAWN's representativeness and related analysis.

Development of Alternative Sites of Emergency and Urgent Care

Over the past 2 decades, specialized centers of care have been developed within hospitals to expedite services and reduce costs. Ongoing pressure to contain these costs and create efficient lines of service will likely expand these specialized services (Johnson, 1998). The proliferation of such services could divert patients away from the ED.

Some of the available specialized services include the following:

- Pediatric EDs, specializing in emergency services for children;
- Chest pain centers, specializing in diagnosing and treating chest pain related to cardiac events;
- Psychiatric EDs, specializing in emergency services for psychiatric disorders;

- Urgent care centers, specializing in expeditious treatment of urgent medical conditions that would be assigned a low priority status in an ED; and

- Observation units, designed to provide short-term patient beds for conditions that do not warrant hospitalization under managed care rules.

The DAWN data collection contractor has found that 33 percent of participating hospitals in the 21 oversampled metropolitan areas have one or more specialty units within the ED – 14 percent have psychiatric emergency units, 4 percent have emergency surgery units, 14 percent have pediatric emergency units, and 9 percent have trauma centers. In some EDs, patients admitted to these specialty units are first triaged though the ED admitting process. In other EDs, patients are admitted directly to the units. The admission and triage process is important for DAWN in that different processes may render different sets of medical records available for DAWN reporters. If cases are triaged before they enter the ED, those cases may not be available for review and fewer DAWN cases may result. On the other hand, if cases are triaged to specialty units after first arriving in the ED, those files may be available for review even though the patients were not treated in the ED.

One particular concern raised by the 1997 OAS review panel was the potential diversion of DAWN-reportable cases to free-standing urgent care centers and the need to consider incorporating these facilities into the DAWN sampling frame. A variety of urgent care centers now operate throughout the United States. Emergi-centers, for example, provide a full spectrum of emergency services on a 24/7 basis. Others provide less comprehensive services on a more restrictive basis. These centers offer both walk-in and appointment services with a primary care provider, and many have expanded hours and shorter waiting times than in EDs (Mezey, 1999). Urgent care centers present an additional complication, in that there is wide variability in the number of centers serving any location.

The structure of urgent care centers can vary considerably. Some urgent care centers are part of physician group practices with expanded hours. Others are clinics affiliated with hospitals, either at the hospital site or in a free-standing location. There appear to be two types of patients who find these care centers attractive (Mezey, 1999). The first type wants the care and access provided by EDs, without the wait or "negative feedback" for using EDs for non-urgent problems. The second type includes those patients whose insurance plans treat urgent care centers preferentially compared with private physicians' offices.

It is possible that freestanding urgent care and emergi-centers treat a substantial number of persons with serious drug-related health conditions. There is no literature, however, that describes the number of patients treated in these settings for drug-related problems.

Growth of Managed Care

Managed care has been one of the most obvious sources of change in the health care system over the last 20 years. The 1997 OAS review panel discussed at length the issue of managed care's potential impact on DAWN. The panel assumed that managed care significantly influenced the size and composition of the population that uses ED services, thereby affecting DAWN's validity.

Managed care is a broad term for practices designed to decrease costs or limit unnecessary services while increasing the quality of health care. The literature reveals its highly controversial nature. Critics claim that managed care practices decrease short-term expenses at the cost of patients' well-being, creating additional costly medical problems. Proponents of managed care point to improvements in monitoring the quality of care, providing continuity of care across different sections of the health care system, and curtailing costs that would otherwise place medical care outside the reach of many persons. There is little consensus about the effects of managed care on utilization and quality of care, in general, and little about the effects of managed care on ED utilization, in particular.

The proportion of persons covered by commercial managed care contracts has increased several-fold in the last 15 years. This change affects EDs because managed care plans, and especially health maintenance organizations (HMOs), have sought to reduce costs by diverting what are viewed as "medically inappropriate," nonurgent visits from the ED to primary care networks or urgent care centers. This should have systematically reduced the number of cases seen in EDs.

Managed care practices discourage persons with nonurgent conditions from seeking care at the ED, based on the assumption that nonurgent conditions can be more effectively treated in primary care settings and at a much lower cost. The literature describes several managed care strategies: preauthorization, denial of payment, special triage telephone numbers, patient education, increase in co-payments, primary care outreach, urgent care centers, and risk-sharing with primary care networks. Preauthorization and denial of payment for treatment of non-emergent conditions have been the most controversial—the diagnosis cannot always be determined until after tests have been performed at the ED. In order to curtail denial of payment, states have enacted a "prudent layperson" standard. This requires the HMO to pay for services if the symptoms would be judged by a prudent layperson to be potentially serious.

Literature that examines the effects of managed care on ED utilization is contradictory. For example, studies have documented mixed effects of preauthorization (Fisher, 1999; Hurley, Freund, & Taylor, 1989; Ling, Cooke, & Kornfeld, 1995). Researchers at the Center for Studying Health System Change have found no evidence to suggest significant effects of managed care on ED utilization (Tu et al., 1999). Using private sector data from their Community Tracking Study's household telephone survey, they focused on whether belonging to an HMO influenced the report of ED utilization among individuals with private health insurance. The model used was careful to correct for local market effects. No relationship was found between HMO membership and self-reported, past-year ED utilization.

Anderson, Zhang and Worzala (1999) examined the effects of low, medium, high, and very high HMO market penetration on ED utilization in 298 metropolitan areas over a 12-year period. Their evidence points to strong effects of managed care on ED utilization in some areas. In addition to a direct effect, HMO penetration had an indirect effect on medical utilization because insurers anticipated the coming of HMOs into the local market and behaved accordingly. Finally, a 1997 survey of chairs of academic departments of emergency medicine revealed a mixed message – 34 percent believed that managed care had been significantly or primarily responsible for a low rate of increase in patient volume, while 40 percent believed that managed care was not responsible (Counselman et al., 1998).

There appear to be several reasons for these mixed findings regarding the effects of managed care on ED utilization. First, managed care effects are highly localized. The rate of managed care penetration varies significantly by state, by sector, and by metropolitan area. For example, in 2000, 90 percent of Medicaid patients were served under managed care contracts in Colorado but only 6.3 percent in Louisiana (Health Care Financing Administration, 2000). Furthermore, managed care services are more heavily concentrated in metropolitan areas than in rural areas (Ricketts, Slifkin, and Johnson, 1995). For example, Sacramento County had commercial penetration rates of 75 percent in 2001, even though the California commercial rate overall was around 50 percent (Cattaneo and Stroud, 2001). Other factors affecting managed care practices include the strength of local provider organizations, the nature of contracted benefits, local market competition, and state legislation and regulation. These factors vary greatly and change rapidly (Miller and Luft, 1994). A study conducted in one location may produce findings contrary to a study conducted in a different location.

Second, managed care itself is evolving – its effects are difficult to identify and interpret. For example, in addition to HMOs, managed care organizations now offer less restrictive Preferred Provider Organizations (PPO) and Point of Service (POS) plans. Though once credited with decreasing ED utilization, managed care in the form of less restrictive PPO and POS plans may be responsible for recent increases in ED utilization. For example, a Boston staff-model HMO recently transformed itself into a medical group serving multiple managed care plans. Under the new structure, reducing ED utilization was no longer financially rewarded, and the group scaled back its urgent care network, increasing pressure on local EDs (Brewster, Rudell, and Lesser, 2001).

Third, national statistics about persons served in the ED conceal substantial variation across facilities and geographic areas. Even hospitals within the same community can experience divergent conditions (U.S. General Accounting Office, 1993). For example, 82 percent of patients presenting to a Los Angeles public ED in 1992 reported having no form of public or private medical insurance (Baker et al., 1994). In contrast, NHAMCS data for the same year estimated that self-pay was the expected source of payment for 14 percent of all ED patients nationally. Similarly, the prevalence of substance abuse among ED cases may vary considerably among sites. Such variation ranges from 9 percent to 47 percent, depending on the patient population, its location, and when the measurement takes place (el-Guebaly, Armstrong, & Hodgins, 1998). The correlates of drug abuse also seem to vary. For example, alcohol's involvement in injury varies according to the type and location of ED and the drinking patterns of the region in which the ED is located (Cherpitel, 1997). This local variation in demographics and substance abuse patterns makes overall change difficult to detect.

In summary, a literature review yielded little useful information about how health system change has affected ED utilization and DAWN counts of substance abuse cases. The review did reveal important information about factors that influence where persons seek health care. Drug-related conditions and emergent medical illnesses (e.g., cardiac problems) generally result in ED utilization. For non-emergent conditions, the decision to access the ED may be mediated by lack of insurance, access to other health care settings (including primary care, urgent care, or specialty centers), and incentives or disincentives related to managed care practices.

Because the ED is the only health care setting that is required to treat persons without health insurance, lack of medical insurance is a strong predictor of ED utilization for uninsured

persons with nonurgent problems. The literature suggests that persons living in neighborhoods without easy access to primary care facilities tend to use the ED. Alternatively, persons with insurance coverage may find it more convenient to access urgent care and other specialty sites rather than the ED. Finally, managed care organizations can divert utilization from the ED through a number of different strategies, including higher copayment, preauthorization, and refusal to pay for nonurgent visits.

ANALYSES OF NATIONAL DATA

This section describes a series of secondary analyses of existing national data that were undertaken to identify any systematic changes in ED utilization over the past several years. Data from NHAMCS and MEPS were used in these analyses.

NHAMCS is the most comprehensive source of information on ED utilization in the United States. This survey has been conducted annually since 1992 by the National Center for Health Statistics (NCHS). Data are collected on patients' symptoms and demographic characteristics, diagnoses, services provided, drugs prescribed, and referral status from a national sample of 524 non-federal, short-stay general hospitals. Each participating hospital provides encounter information on a target sample of 50 ED visits during a 4-week reporting period. About 71,000 visits are sampled annually. Data are weighted to produce annual national estimates. This section describes analyses of NHAMCS public-use data files from 1992-97 (the most recent data files available at the time this task was implemented). Unfortunately, there are no known analogous data systems providing utilization data in the ED for the years prior to 1992.

NHAMCS allows for some exploration of the extent of drug-related diagnoses in the ED population. NHAMCS originally included a variable on its data collection form noting whether the case was alcohol- or drug-related, but it contained a considerable amount of missing data in later years. This variable was dropped from the form in 1996. Consequently, analyses in this chapter focus on a set of alcohol and drug-related (ADR) ICD-9-CM diagnostic codes. ADR cases were defined as any case to which a set of six specific ICD-9-CM codes had been assigned:

- 291.0 and subcodes (alcoholic psychoses);
- 292.0 and subcodes (drug psychoses);
- 303.0 and subcodes (alcohol dependence syndrome);
- 304.0 and subcodes (drug dependence);
- 305.0 (nondependent abuse of alcohol); and
- 305.2 - 305.9 (nondependent abuse of drugs).

These codes identified the most likely ADR cases; no attempt was made to replicate the DAWN case definition in the analyses.

MEPS is a nationally representative survey of health care use, expenditures, sources of payment, and insurance coverage for the U.S. civilian, noninstitutionalized population. It also includes a national survey of nursing homes and their residents. This survey is designed to yield comprehensive data that estimate the level and distribution of health care use and expenditures, monitor the dynamics of the health care delivery and insurance systems, and assess health care policy implications. The third of a series of surveys on this topic, MEPS follows on the National Medical Care Expenditure Survey (NMCES, also known as NMES-1), conducted in 1977, and the National Medical Expenditure Survey (NMES-2), conducted in 1987. The MEPS Household survey employs an overlapping panel design to collect medical expenditure data at both the person and household levels. These data are then linked with additional survey data collected from the respondents' medical providers, employers, and insurance providers. The following analyses draw upon the 1987 NMES and the 1996 MEPS public-use data files (Agency for Health Care Policy and Research [AHCPR], 1991,1998).

National Trends in ED Utilization

The rate of ED visits remained stable at about 36 visits per 100 persons from 1992 to 1998. The overall number of visits to EDs increased from 89.8 million in 1992 to 100.4 million in 1998, in proportion to the rise in population (McCaig, 2000; Schappert, 1997). At both points in time, the most frequent users of the nation's EDs were females between the ages of 25 to 44 (roughly 16 percent of all ED visits), followed by males of the same age range (14 percent of all visits). In both 1992 and 1998, whites accounted for about 80 percent of all ED visits, or about 34 visits per 100 persons. Blacks accessed the ED at a much higher rate than whites, and this rate increased, rising from 55 visits per 100 persons in 1992 to 62 visits per 100 persons in 1998. Studies have shown that higher ED rates for minorities may be related to inadequate access to primary health care among these populations (Baker et al., 1994; Young et al., 1996).

Table 2-1 provides some general information about how ED utilization has changed in recent years. This table shows weighted estimates from NHAMCS for 1993-97, including the total number of ED visits annually and the number of ADR visits. As shown, there was no significant change in the number or population-based rate of ED visits from 1993-97. However, the proportion of ED visits with ADR diagnoses experienced a small, steady, and statistically significant increase from 1993-97. Data from DAWN (not shown) indicate a significant increase in the number of DAWN cases over the same 5-year period (SAMHSA 1996a, SAMHSA 1996b; SAMHSA 1999b, SAMHSA 1999c, SAMHSA 1999d).

Table 2-1. Trends in ED Utilization, 1993-97 (NHAMCS data)

	1993	1994	1995	1996	1997
US Population (in 1,000s)	257,746	260,289	262,765	265,190	267,744
All ED Visits	90,265,163	93,401,037	96,543,579	90,345,526	94,934,191
(SE)	(4,839,453)				(4,553,200)
Per 1,000 Population	350.21	358.84	367.41	340.68	354.57
(SE)	(18.8)				(17.0)
ADR Visits	1,160,202	1,147,700	1,376,870	1,434,310	1,449,645
(SE)	(97,450)				(120,974)
Per 1,000 Population	4.50	4.41	5.24	5.41	5.41
(SE)	(.38)				(.45)
As % of all ED Visits	1.30%	1.23%	1.43%	1.59%	1.53%
(SE)	(.08%)				(.10%)

SOURCE: analysis of NHAMCS public-use data files, informed by Nourja (1999) and Schappert (1997).

In order to investigate whether increases in DAWN counts and ADR visits to the ED are related to health system change, the following sections examine data on lack of health insurance and managed care.

ED Utilization Among the Uninsured

Information on expected source of payment in the ED – especially payment information specific to substance abuse cases – is difficult to find and interpret. In an effort to keep up with rapid changes in managed care and insurance coverage arrangements, NHAMCS changed its payment source categories several times between 1992 and 1997. This renders comparisons of different timepoints difficult, and it also highlights the problems of trying to collect consistent data on insurance coverage, which is constantly in flux.

NHAMCS does not include an uninsured category on its encounter form. Instead, uninsured cases were identified as those with the patient as the expected source of payment (i.e., “patient paid”). Because multiple-response categories were permitted in 1993, any visits that may have involved copayments (i.e., those that also indicated some form of insurance coverage) were excluded from this group. In 1997, the payment variable was structured such that copayments were not counted in the “patient paid” category. Table 2-2 compares the proportion of “patient paid” cases in 1993 and 1997. These data show that the total number of self-paying patients in the ED increased by about 30 percent from 1993 to 1997, and that self-pay visits as a percentage of all ED visits rose by about 3 percent (a statistically significant change). More importantly, the total number of self-paying patients seen in the ED for alcohol and drug-related diagnoses increased by 80 percent, to about 12 percent of all ADR ED visits. In 1997, over 40 percent of patients seen in the ED for ADR diagnoses had no public or private health care coverage for their ED visit.

Table 2-2. ED Cases with Patient as Expected Source of Payment, 1993 and 1997

	1993	1997
Total Number of ED Visits	90,265,163	94,934,191
ED Visits with Patient as Expected Source of Payment	11,690,000	15,260,000
(SE)	(665,438)	(789,682)
As Percentage of All ED Visits	13.0%	16.1%
(SE)	(.25%)	(.31%)
Number of ADR Visits to the ED	1,160,202	1,449,645
ADR ED Visits with Patient as Expected Source of Payment	328,324	593,010
(SE)	(43,786)	(69,677)
As % of All ADR ED Visits	28.3%	40.9%
(SE)	(2.9%)	(3.3%)

SOURCE: analysis of NHAMCS public-use data files

These findings may indicate an increase in the number of uninsured persons with nonurgent conditions who have accessed the ED over time. If the lack of insurance leads to use of the ED rather than other medical sites, DAWN would detect an increased rate of substance abuse. An influx of the uninsured into the ED, however, would not result in a corresponding national increase in substance abuse problems. In order to understand whether such a bias affects DAWN, more information is needed on sources of payment and the acuity of DAWN cases.

ED Utilization and Urgency of Visits

While no information is available on the acuity of DAWN cases specifically, NHAMCS collects this information for its sample. Table 2-3 shows trends in the acuity of ED visits from 1993 to 1996. In NHAMCS, an urgent visit is defined as involving immediate attention for an acute illness or injury that threatens life or function, where delay would be harmful to the patient. Nonurgent visits were defined as not requiring attention immediately or for a few hours. Data from 1997 were not included in these analyses because changes were made to the acuity variable, rendering direct comparisons with earlier years impossible.

Table 2-3 shows a small (1.2%) but statistically significant increase in the percentage of ED visits made for urgent/emergent conditions between 1993 and 1996. There may be several reasons for this increase. If managed care has successfully implemented practices that divert nonemergent cases from the ED, the proportion of urgent/emergent visits to the ED should increase. Alternatively, shortened hospital stays and longer waits for patients attempting to access primary care through managed care might lead to the development of more acute conditions requiring immediate treatment in the ED.

Table 2-3 also shows that ADR visits are more likely to be categorized as urgent than are visits for other diagnoses. For example, 57 percent of all ADR cases were characterized as urgent in 1996, compared to 46 percent of ED visits overall. Although the proportion of all ED visits designated as urgent/emergent increased, the increase is in non-ADR visits, which

showed no change in urgency. The finding could reflect a relatively low level of statistical power due to the small number of ADR visits relative to the extraneous variance in the analysis. Alternatively, because a high proportion of ADR visits is already urgent/emergent, ADR visits may be relatively impervious to diversionary strategies. In order to assess how vulnerable DAWN counts are to strategies that divert nonemergent cases from the ED, more information is needed about how many DAWN cases are urgent/emergent.

Table 2-3. Trends in Urgent/Emergent ED Visits, 1993-1996

	1993	1994	1995	1996
All ED visits	90,265,163	93,401,037	96,543,579	90,345,526
Urgent/Emergent Visits	40,575,472	44,090,728	44,193,451	41,732,823
(SE)	(2,200,483)			(1,738,503)
Per 1,000 Population	157.4	169.39	168.19	157.4
(SE)	(8.5)			(6.55)
As % of all ED Visits	44.95%	47.21%	45.78%	46.19%
(SE)	(.37%)			(.42%)
Urgent+Emergent ADR Visits	722,706	663,067	784,410	817,346
(SE)	(70,879)			(79,091)
Per 1,000 Population	2.80	2.55	2.99	3.08
(SE)	(.28)			(.57)
As % of all ADR Visits	62.3%	57.77%	56.97%	57.0%
(SE)	(3.1%)			(3.2%)

SOURCE: analysis of NHAMCS public-use data files

Effects of Managed Care on Ambulatory Utilization Patterns

The effects of managed care on ED utilization can be examined by looking at the pattern of ambulatory care utilization for both managed care and fee-for-service (FFS) patients. There are very few data sources that report data from across the nation's ambulatory care system. Supplemented with data from a companion survey, the National Ambulatory Medical Care Survey (NAMCS) serves this purpose well. Table 2-4 shows combined data from NHAMCS and NAMCS describing national utilization of ambulatory services in 1996 (Schappert, 1998). The table shows the distribution of all visits made to ambulatory care settings by patients with different insurance arrangements in 1996.

Of all ambulatory care visits paid by FFS insurance, 10.3 percent were to EDs, 6.1 percent to outpatient departments, and 83.6 percent to physicians' offices. In contrast, patients with expected payment under a commercial HMO/prepaid system were less likely to use the ED—only 6.8 percent of all ambulatory visits for this group were to the ED and 87.1 percent were made to physicians' offices. Ambulatory care visits by patients covered under commercial PPOs, a less stringent form of managed care, had only 6.6 percent of visits made to the ED and nearly 90 percent to physicians' offices. Patients under commercial managed care arrangements had relatively lower rates of ED utilization compared to their FFS counterparts.

Table 2-4. Use of Ambulatory Care by Insurance Status, 1996

	Emergency Departments N=90,347		Outpatient Departments N=66,186		Physician Offices N=734,493		Total N=892,025
	% (SE)	n	%	n	%	n	%
Private							
FFS	**10.3%** (.56)	18,521	6.1%	10,951	83.6%	150,571	100%
HMO/Prepaid	**6.8%** (.58)	7,770	6.0%	6,853	87.1%	99,891	99.9%
PPO	**6.6%** (.70)	5,059	3.1%	2,419	89.8%	69,042	99.5%
Medicaid							
FFS	**20.3%** (1.26)	12,739	20.4%	12,765	58.6%	36,725	99.3%
HMO/Prepaid	**13.4%** (1.64)	3,524	13.8%	3,628	72.8%	19,097	100%

SOURCE: Schappert (1998). N and n are in thousands; row totals may not sum to 100% due to rounding. SE calculated using combined settings coefficients.

Medicaid patients had similar tendencies. Patients with FFS Medicaid had higher rates of ED utilization (20.3% of ambulatory care visits for the group) compared to those under HMO Medicaid arrangements (13.4%). Findings from both private and Medicaid sources show that ED utilization relative to the rest of ambulatory care visits is highest under FFS as compared to managed care. Such findings are consistent with managed care's objective of reducing ED visits and increasing primary care visits.

Though these data provide some evidence that ED utilization is lower under managed care, there are three important caveats. First, the reliability of NHAMCS and NAMCS data on expected source of payment is unknown. Coders were asked to specify the kind of insurance (private vs. Medicare, Medicaid, etc.) and the type of payment (PPO, HMO, FFS, self-pay, no charge, and other) associated with the medical visit. Much of the data, however, are missing for type of payment – 13 percent of privately insured individuals and 36 percent of Medicaid patients had no type of payment specified. NHAMCS/NAMCS attempted to capture better data in 1997 with redesigned variables, but this also resulted in substantial missing data. Central to this issue seems to be difficulty in achieving consensus on the coding of diverse managed care arrangements. For example, though no formal PPOs are in place under Medicare and Medicaid, some states may utilize a similar system for managing costs, and some data collectors have coded this. In spite of its limitations, NHAMCS/NAMCS data were included in this report because there is no other source that provides the same richness of information about medical visits across emergency and ambulatory sites at a national level. Furthermore, the data illustrate the difficulties involved in trying to determine how managed care affects ED utilization.

While the findings in Table 2-4 are consistent with the successful implementation of managed care strategies to decrease ED utilization, there are several explanations that could account for the relatively low rate of ED visits under managed care. HMOs expend considerable effort and seem to be successful in increasing primary care contact with their members (Tu, Kemper, & Wong, 1999). The differences in the patterns of ambulatory care utilization may be due to increased primary care contact, rather than decreased ED utilization. Managed care organizations have traditionally attracted and actively recruited individuals who are healthier, and differences in the proportion of ED visits may be due to selection bias (or adverse selection) that leads to higher utilization for FFS patients. Unfortunately, NHAMCS and NAMCS provide little information on client histories and general health, which would permit analyses sensitive to case mix.

A related issue is whether the utilization pattern described above is attributable to managed care's systematic diversion of non-urgent cases from the ED. If the lower ED utilization rate is due to the implementation of managed care practices diverting nonurgent cases from the ED, then most of the ED cases under managed care will be urgent/emergent cases. Similarly, managed care diversion practices should result in a higher proportion of urgent/emergent cases when compared to FFS cases. Table 2-5 shows the proportion of NHAMCS ED urgent/emergent visits, by type of insurance, for 1993 and 1996. The trend data in this table must be interpreted with caution, since the NHAMCS insurance categories changed markedly between 1993 and 1996. Nevertheless, it is likely that the relationships between HMO-covered visits and FFS-covered visits within each year are relatively robust.

Contrary to expectation, there was no difference in 1993 between commercial managed care and FFS cases in terms of the urgency of the condition for which they were treated. This could be because managed care practices had no effect on the acuity of conditions treated in the ED. Alternatively, the statistical power for detecting the effect may be too low, given the amount of variability contributed by other factors and the low number of cases for which managed care was the expected source of payment.

However, in 1996, there was a statistically significant difference in the acuity of cases treated under private managed care compared to acuity in FFS cases. Specifically, cases covered by private HMO arrangements were more likely to be coded as "urgent" than were those under private FFS arrangements. Thus, these data suggest a relationship between managed care and ED utilization, with less urgent cases being diverted from the ED to other settings.

Table 2-5. Urgent/Emergent ED Visits by Type of Insurance, 1993 and 1996

TYPE OF INSURANCE	Percent of ED Visits Labeled "Urgent," 1993		Percent of ED Visits Labeled "Urgent," 1996	
	Percent (SE)	N	Percent (SE)	N
Private HMO	45.2% (1.4)	6,421,194	47.2% (1.01)	15,450,000
Private FFS	43.9% (.65)	28,440,000	44.5% (.92)	18,430,000
Medicaid HMO	46.5% (10.6)	50,453	40.1% (2.07)	3,542,202
Medicaid FFS	38.8% (2.4)	8,100,442	44.0% (1.0)	15,730,000
Self Pay	41.5% (1.0)	11,690,000	42.8% (1.0)	15,190,000

SOURCE: analysis of NHAMCS public-use data files

The interpretation of findings for Medicaid data is less straightforward. There were no significant differences in acuity of patients covered by either HMO or FFS payment systems. In 1993, there were too few patients in the Medicaid HMO category to create enough statistical power. In 1996, there was a tendency for Medicaid HMO cases to be less urgent than FFS cases. Though this difference did not quite reach statistical significance, it may be indicative of a selection effect – states have tended to enroll their healthiest Medicaid patients in HMOs as opposed to FFS programs (Zuckerman, Evans & Holahan, 1997).

In these analyses, self-pay cases had the lowest level of urgent/emergent status. This is consistent with assertions that persons without insurance use the ED for primary care and less urgent conditions.

Findings from MEPS

To explore further the relationship between managed care and ED utilization, data from the 1987 and 1996 MEPS were analyzed. Whereas NHAMCS provides information about the population utilizing the ED and other ambulatory services, MEPS provides information about insurance coverage and health care utilization patterns for the general population.

As shown in Table 2-6, patients with HMO-type insurance were significantly less likely to use the ED in 1987 than individuals with non-HMO insurance ($p<.001$). Although the rates of ED utilization decreased for both HMO and non-HMO populations over the next 9 years, the between-group difference remained significant in 1996 ($p<.05$). The differences in ED utilization rates, however, may be due in some part to a selection bias (HMO patients may have a lower ED utilization rate due to better overall health status). No attempt was made to account for differences in health status between the two groups.

Table 2-6. ED Utilization by HMO Status for Insured Persons, 1987 and 1996 (MEPS)

	1987		1996	
	HMO	Non-HMO	HMO	Non-HMO
Mean Number ED Visits	.20	.26	.17	.19
% Persons With One or More ED visits	14.6%	17.5%	12.6%	13.4%
Mean Number ED Visits Among Persons With One or More ED Visits	1.34	1.47	1.35	1.40

SOURCE: analysis of MEPS public-use data files

In summary, findings from both MEPS and NHAMCS demonstrate that lack of insurance and managed care affect the ED population from which DAWN detects its cases. However, interpretations of these findings are equivocal because of changes in NHAMCS and MEPS variables over time, possible selection bias effects in managed care, and diverse and rapidly changing managed care practices. Furthermore, because the size of the effect is unknown, this research yields no conclusive evidence that one or more health system changes have *systematically* and *consistently* affected EDs nationwide in ways that are consequential for DAWN.

The inconclusive literature review did not dispel lingering concern about the amount, source, and impact of "noise" being introduced into the DAWN data by factors related to health system change. In particular, little is known about how the highly variable number of alternative medical sites and the characteristics of the managed care market affect persons with substance abuse problems who might seek help in the local ED. It was unknown whether data collection for DAWN from those alternative sites was either warranted or feasible. For this reason, a qualitative study of the health care system in four cities was conducted. ED staff, emergency services staff, and other health care providers contributed information about where persons with substance abuse problems seek health care. This study is described in detail in the following section.

QUALITATIVE RESEARCH ON LOCAL HEALTH SYSTEM IMPACTS

A qualitative study was conducted to describe the role of the ED in the treatment of substance abuse problems and the changing factors that influence whether patients present for care there or elsewhere. To accomplish this, a series of focus groups was convened to assess what recent changes have occurred and are anticipated in the organization and location of emergency care for substance abuse. The focus groups included representatives from throughout the health care system. Discussion concentrated on the impact of health system changes on the use of hospital EDs to treat acute substance abuse problems. The resulting qualitative data about the nature and variation of health system change across several cities are to be used to guide decisions about whether to expand DAWN data collection beyond EDs to improve the validity of DAWN as an indicator of drug-related morbidity. Information gathered in focus groups and interviews conducted in four metropolitan areas is used to describe where the

kinds of drug-related problems captured by DAWN are treated. Factors that determine where a person receives medical care are identified, along with the potential for these factors to change over time.

The potential for increasing "leakage" or "flooding" of cases is discussed. Leakage of substance abuse cases from the ED (and from DAWN) occurs when cases usually treated in the ED are diverted to other health care settings as a result of changes in the health care system (recent growth of managed care and urgent care centers). Flooding of cases into the ED occurs when these changes shift cases usually treated in alternate settings into the ED.

Procedure

Key informant interviews and five focus groups were conducted. Unstructured key informant interviews were conducted initially to identify focus group participants and to complement the information gathered in focus groups. Key informants were asked about the characteristics of persons with substance abuse problems seen in their facilities, what barriers exist to care for this population, and what changes in access have occurred. Names of key informants and focus group members were generated using the snowball sampling technique; each informant was asked what other individuals could provide important viewpoints regarding substance abuse problems and treatment in their community. Special efforts were made to talk to individuals whose names were mentioned frequently by previous informants.

Because a comprehensive view of access to health care by persons with substance abuse problems was needed, a broad range of disciplines and professions was included in this study. Focus group members and key informants were drawn from the following professions: police officers (particularly those involved in community policing); emergency medical services personnel (fire and rescue, paramedics, emergency medical technicians); substance abuse treatment providers; employee assistance professionals (EAPs); ED staff (including nurses, doctors, and managers); medical staff from community clinics; social workers in medical clinics and EDs; urgent care/triage staff; substance abuse prevention/harm reduction workers; psychiatric ED/crisis center staff; and public health administrators.

The first focus group involved ED physicians at an annual conference of the American College of Emergency Physicians (ACEP). Since many of the participants were administrators as well as clinicians, and because they were involved and interested in public health issues at a national level, this group provided an overview of issues concerning substance abuse in EDs across the country. The questions asked of these experts included the following:

- How does substance abuse or the use of illicit substances present in the ED? Are there problems related to substance abuse that are of particular importance due to severity of the illness? Are there particular kinds of cases that you feel should be monitored for public health reasons? Why?

- What factors affect whether persons with substance abuse problems are seen in the ED, as opposed to other health care sites? Have these factors changed? How has managed care affected the population you see in your ED? Has managed care affected the number or characteristics of persons with substance abuse problems you see? Why or why not?

An additional focus group was conducted with a range of professionals in each of four cities (Seattle, Phoenix, Miami, and Boston). These cities were chosen because they were geographically dispersed and because background information on their respective health care systems was available through ongoing work by the Center for Studying Health System Change. Persons from different organizations in the community were contacted because substance abuse presents differently, depending on where in the community a person is seeking help. For example, police and emergency medical services personnel have frequent contact with persons who are intoxicated or unconscious from substance use; medical social workers and clinic staff are more aware of the chronic medical problems associated with abuse.

In order to ensure that focus group respondents were discussing the same subject, they were asked questions about how persons with particular substance abuse-related problems access care. These problems constitute most of the substance abuse-related problems seen in EDs and detected in DAWN. They include drug overdoses, seizures, chest pain, injuries related to fights or accidents, psychiatric emergencies (e.g., hallucinations, depression), intoxication, conditions related to injection drug use (e.g., abscesses, cellulitis), organ damage related to substance abuse (e.g., liver damage, pancreatitis), withdrawal, and requests for substance abuse detoxification or treatment.

Respondents were asked to identify the settings that treat each of these substance abuse problems in their community. Problems involved alcohol as well as drugs, and sites included those providing mental health and substance abuse treatment as well as medical treatment. Respondents were asked the following questions:

- How and why do people seek help for this substance abuse problem?
- What setting is contacted? Where do the patients/clients go? What factors determine where a person goes for care?
- Where does the ED fit into the range of health care options available for persons with a substance abuse problem? What factors determine whether a person goes to the ED or to an alternative setting?
- Who in your community would have an important perspective on issues related to access to health care for people with substance abuse problems?

Results: Emergency Physicians Focus Group

ED physicians at the annual ACEP conference made several important points. First, they noted that the most widespread source of health system change, managed care, has not decreased ED caseloads recently. In fact, managed care may have increased visits to the ED because primary care visits are closely scheduled under managed care, leaving limited space for patients who required same day or even next day treatment.

Second, respondents did not expect that managed care practices would affect ED visits related to substance abuse for several reasons:

(a) There is limited access to primary care or urgent care providers late in the evening or on weekends. The ED is still the site of choice during those hours when most problems related to drug use occur.

(b) Because managed care dictates what provider a patient may see, many patients are forced to switch providers. These forced changes lead to less reliance on their primary provider and more incentive to seek care at the ED.

(c) The ED may be preferred by patients who do not want their primary care provider to know of their substance abuse problem.

Results: Metro Area Focus Groups

Qualitative study of four metropolitan areas revealed that the ED plays an important role in the treatment of substance abuse problems in every community. Different kinds of substance abuse problems are routed through the health care system in very different ways, leading to differences in vulnerability to diversion to or from the ED. Substance abuse conditions treated in the ED can be grouped in four categories:

(1) Urgent medical conditions

(2) Psychiatric emergencies

(3) Less urgent medical conditions

(4) Visits related to public health

Urgent Medical Conditions

There was clear consensus that the vast majority of urgent medical problems were sent to and treated almost exclusively in the ED, and that this practice was stable across cities and over time. The most urgent substance abuse-related problems were identified as overdoses, chest pain, seizures, and major injuries/accidents (including threat to life or long-term normal functioning). Urgent conditions such as these are rarely diverted from the ED. Therefore, the number of urgent medical cases is likely to provide a valid indicator of the level of drug-related morbidity for this group of conditions.

Psychiatric Emergencies

In addition to treating urgent medical conditions, the ED plays an important role in the treatment of psychiatric emergencies. In the cities studied, most of the public health systems rely on the ED for medical clearance before an on-site psychiatric assessment. However, some managed care companies and one city provided clearance and assessment in independent

psychiatric facilities. Also, it was found that the role of the ED in treating psychiatric emergencies has been variable over time. In the private sector, access to alternative psychiatric sites changes according to the contractual arrangements of managed care with employers and with the sites themselves. In the public sector, access to freestanding emergency psychiatric facilities changes according to public health funding. Substance abuse cases involving psychiatric emergencies seem to move into and out of the ED as managed care and public health policies change.

Less Urgent Conditions

The ED and alternative sites also treats a number of other substance abuse-related problems that are universally regarded to be less urgent. The problems identified as less urgent are minor injuries/accidents, organ damage/chronic illnesses related to drug use (e.g., pancreatitis, hepatitis, etc.), illnesses related to the administration of drugs (e.g., cellulitis, abscesses, etc.), withdrawal, and request for substance abuse treatment or detoxification.

Because the ED is not the primary setting for treating less urgent drug-related conditions, the number of ED cases depends on the perceived acuity of the condition and access to other health care sites. When treatment at other health care settings is unavailable or inconvenient, people come to the ED. Access to alternative sites varies across cities and over time due to local factors that are numerous and rapidly changing. Though data collection was limited to four cities, the study revealed six factors affecting ED utilization for less urgent conditions associated with substance abuse:

Availability of publicly funded primary care sites for the uninsured. Since most primary care sites will not treat people without insurance, many uninsured people seek care in EDs, which are required by federal law to provide evaluations and basic treatment. Some cities set up primary care clinics to treat the uninsured, but the number of these clinics and the level of funding vary between cities and over time. For example, Boston and Seattle appear to have well-developed systems serving this population. Miami has some specific clinics available for the uninsured and indigent, but Phoenix seems to have a poorly developed infrastructure to serve this population. A relatively large number of substance abuse cases without insurance are treated in community clinics in Boston and Seattle. In contrast, because Phoenix reportedly lacks an adequate system for serving the large number of medically indigent persons in that city, the ED is flooded with nonurgent cases, including those involving substance abuse.

Police procedures. Local law enforcement policies determine whether and how intoxicated persons encounter the health care system in the course of police processing for crimes. For example, Miami police require evaluation of persons with an altered mental status at the ED before transport to jail, but Phoenix does not. EDs in cities where police are required to obtain medical clearance for intoxicated persons are likely to be “flooded” with intoxication cases. The vast majority of these cases is likely to be intoxicated with alcohol. As police procedures change, the number of intoxicated persons seen in the ED will change.

Managed care policies. Reports from the Center for Studying Health System Change and conversations with key informants suggest that the face of managed care varies across metro areas and over time. This variation is related to complex factors such as market competition, state legislation, employer preferences, and the status of providers.

Rather than decreasing ED utilization, managed care is now blamed in several cities for poor access to primary care doctors. Physicians are booked too tightly to allow insured people to be seen without a long wait. The delay for treatment has increased in all four cities over the last 10 years, but delays still vary across cities (e.g., delays in Phoenix are longer than in Boston). Increasingly, people with managed care insurance use the ED because they are unable to see a primary care provider in a timely manner. Rather than diverting cases from the ED (see the analysis of 1996 NHAMCS data above) in many cities managed care organizations seem to be responsible for the increased use of EDs by insured persons for less urgent conditions.

Access to urgent care. Urgent care exists in three different forms: as extended hours in primary care offices, as an adjunct unit to the ED, and within stand-alone clinics. Different forms of urgent care have waxed and waned in the four cities over time – the effects on EDs have been variable over time across cities. For example, a Boston HMO has gradually restricted hours for urgent care in its primary care sites, and the number of stand-alone urgent care centers has plummeted in the last 10 years. A Seattle HMO seems to be increasing access to urgent care in a well-to-do suburb. Urgent care sites unaffiliated with EDs treat mainly the privately insured, and they have a reputation for turning away all others. Urgent care staff reported that substance abuse is rarely identified or documented in their facilities, for several reasons. First, the less critical injuries seen in urgent care are usually treated many hours after the injury event, when any trace of a drug is likely to be gone from the patient's system. Second, the focus of urgent care clinicians is the rapid treatment of acute conditions. Questions about substance use are not typically asked, and if substance use is mentioned, it is often not documented because it is not perceived to be relevant for the treatment of the acute condition. Third, for those urgent care sites unaffiliated with the primary care clinic, medical records are not typically available, and information about historical symptoms, which raise questions of undiagnosed substance abuse, cannot be examined.

Urgent care may be responsible for leakage of some nonurgent problems from the ED, but the extent of the leakage varies across cities and its total volume is unknown. In addition, two practical issues make DAWN data collection from these sites infeasible for future study: rapid changes in the location, structure, and operation of specific facilities; and poor identification and documentation of substance abuse in the records of persons treated.

Availability of needle exchange programs. Some cities have established needle exchange and other harm reduction programs that treat nonurgent drug abuse and other health problems that would otherwise be seen in the ED. For some IV drug users, these programs are their only contact with any segment of the health care system. Focus groups included representatives from needle exchange programs in Boston and Seattle; no such program is available in Phoenix, and none was mentioned by the Miami respondents. Where these programs exist, they are likely to reduce the number of IV drug abusers accessing emergency care. However, needle exchange programs are highly susceptible to local political agendas and will vary across geographic areas and over time.

Access to substance abuse treatment. Informants in all four cities noted that there have been fewer resources available for substance abuse treatment recently, as a result of decreases in benefit coverage by private insurance and a decrease in detox facilities. However,

the degree of burden experienced by the EDs as a result of these changes seems to vary considerably. Individuals in Phoenix report a crisis, where substance abusers come in and out of the ED repeatedly with no improvement in their addiction problem. In that city, respondents clearly linked lack of services to higher ED visits related to substance abuse. In contrast, Boston EDs seem to be coping more successfully with the increased burden.

In summary, the ED and many other sites provide care for less urgent conditions associated with substance abuse. Substance abuse cases are susceptible to diversion (leakage) or flooding. The degree of diversion or flooding varies across cities and over time according to a number of factors. Moreover, it is not readily feasible to capture nonurgent substance abuse cases for surveillance through the expansion of DAWN data collection beyond EDs for three reasons: (1) the large number of alternative sites; (2) the high variation in the number and characteristics of alternative sites between cities; and (3) the constant change in resource allocation that affects patients' access to these sites.

ED Visits Related to Public Health Policy

In addition to the treatment of medical conditions, the ED serves as a point of access for public health services for two groups of patients – homeless, inebriated persons, and persons seeking detox treatment. The degree to which the ED is central to public health management of these patients varies across cities and over time.

Administrative policies for public sector detox treatment. The role of the ED in the delivery of public sector detox services seems to vary significantly among cities. In Boston, patients are required to obtain medical clearance from the ED prior to entering a public detox program. Patients in Miami and Phoenix are evaluated at the detox center first; and only those patients meeting certain criteria are sent to the ED. This difference in administrative procedures is likely to result in a higher number of low morbidity, substance abuse cases in certain cities. Changes in administrative procedure would quickly lead to the diversion of these cases to other sites designated by the public health system.

Public health policy for homeless, inebriated persons. People who are homeless and who are chronically intoxicated often seek care in the ED for a variety of social problems rather than medical conditions associated with substance abuse. In Boston, one of the roles of the ED is to provide access to social services, and intoxicated persons who are "found down" by emergency services personnel are taken to the ED. In Phoenix, a special van is called to take intoxicated persons to a detox center. However, this van service is available only where there are beds available, and the public detox facility is often full. In Seattle, an intoxicated person can be taken directly to a shelter or to a "sobering center" especially designed to divert these cases from the ED. The likelihood of diversion varies over time, and the specific places to which patients are diverted differ across cities and over time. The availability of sites other than the ED that provide treatment for public intoxication and its related social problems appears related to resource allocation at the county level.

Informants indicated that the number of cases involving intoxicated individuals seen in the ED is high, and the vast majority of these cases are intoxicated with alcohol alone. This issue is problematic for the surveillance of alcohol abuse in EDs. Because the number of these cases seen in the ED is determined by local policies, the number of alcohol-related cases reported for

any given community will be a function of the manner in which the community manages both homelessness and public intoxication.

DISCUSSION

This qualitative study suggests that health care system change is ongoing and rapidly shifting. Managed care, which in the mid-1990s was thought to be responsible for decreased ED utilization related to diversion practices, now seems to be responsible for increased utilization related to inadequate access to primary care. Health system change also seems to be highly localized, as evidenced by the large number of local factors that can determine ED access. Thus, there is no single source of change that has affected all DAWN sites in the same way, and it is not feasible to collect data from any single site or group of sites that would quantify the "leakage" of cases from DAWN.

However, because cases associated with different substance abuse conditions are differentially susceptible to leakage and local effects, it makes sense to include data elements in DAWN to differentiate among these conditions. The redesign team has recommended changes to the variables collected about each DAWN case. At a minimum, data elements should include either diagnosis or presenting complaint, along with the disposition of the case. Presenting complaint might be further refined to focus on the major injury/illness categories noted earlier in this report. Together, these data elements can assist analysts in understanding the specific conditions/reasons for which substance abusers seek care in EDs, as well as the relative urgency or severity of the different conditions reported.

This study was designed to gather qualitative information about the factors affecting ED access in a few select cities. The approach cannot quantify the size of the population of cases subject to leakage from EDs. Because of the large number of alcohol intoxication cases seen in many EDs, the less urgent cases are likely to outnumber the more urgent cases. Excluding alcohol intoxication cases, it is unclear whether the remaining, less urgent conditions outnumber the urgent conditions. However, the data suggest that a substantial proportion of the less urgent, substance abuse-related cases are seen in sites other than the ED, and that there are clearly identifiable local factors that determine the degree of diversion (or leakage) to alternate treatment sites. The effects of these factors vary over time and location.

It seems clear that the ED plays an important role in the treatment of substance abuse problems in every community studied. While the ED is the sole setting for the treatment of urgent conditions, there are other settings that treat less urgent conditions associated with substance abuse. As access to these alternative sites changes according to local factors (health care policy, market changes, and funding), cases associated with less urgent conditions are subject to leakage or flooding. While monitoring the number of substance abuse cases seen in the ED can provide important information about the physical consequences of drug abuse, the expansion of DAWN data collection to other health care settings is not recommended. DAWN would benefit, however, from collection of information that would allow analysts to distinguish conditions that are differentially susceptible to leakage and the effects of local health system change. DAWN cannot measure the prevalence of all drug-related illnesses, but available evidence suggests that DAWN is a valid indicator of the nation's substance abuse problem.

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3. DEVELOPMENT OF A NEW SAMPLE DESIGN FOR DAWN

A core component of the development of an alternative design for the Drug Abuse Warning Network (DAWN) included the development of specifications and methods for selecting a new sample for the emergency department (ED) component.[1] As noted in Chapter 1, the 1997 Office of Applied Studies (OAS) review panel and subsequent constituent analyses by the redesign team raised questions about the appropriateness of EDs for data collection, the efficiency of the current sample design, and the quality of estimates produced (notably, the large weights assigned to a number of relatively small facilities, and the relative standard errors obtained). In addition, questions were raised about the possibility of expanding DAWN to encompass new metropolitan areas or rural areas.

Chapter 2 addressed the impact of health system change on the emergency care system and its relevance for DAWN. Based on the conclusions of that extensive research, the redesign team and OAS jointly concluded that continued focus on EDs was warranted. Changes were recommended in other aspects of the redesign (e.g., case definition and data elements) that would enhance the information obtained from those facilities and ensure a better fit between information gathered and the constraints imposed by the settings in which DAWN operates. From a sample design perspective, however, it was determined that DAWN should continue to focus exclusively on general medical, non-Federal, short-stay hospitals operating 24-hour EDs. Within that general constraint, however, there were numerous possibilities for adapting the sample design to meet demands from the users of DAWN for geographic coverage and statistical precision.

This chapter reviews the considerations, constraints, and recommendations resulting from activities focused on redesigning the ED sample for DAWN. At the outset, it should be noted that the redesign team was tasked with developing recommendations for the general parameters of the new sample and a method for drawing the actual sample. The specific facilities that will constitute the new sample, however, were not identified by the redesign team. Because the population of EDs changes rapidly from year to year (due to acquisitions, changes in ownership, mergers, demergers, and closures), OAS requested a method for sample selection, with the actual selection to be undertaken by the DAWN analytic contractor during the implementation of the new DAWN design. This chapter presents an overview of recommendations and a strategy for drawing a new sample for DAWN. All sample size requirements are approximate pending actual selection of the final sample.

[1] Recall that the medical examiner component is not based on a sample of facilities, and the redesign team did not recommend that the DAWN-ME component be restructured to generate statistical estimates. Therefore, this chapter deals only with sampling and estimation strategies for the ED component of DAWN.

OVERVIEW

DAWN monitors changes in drug abuse trends in the United States and within particular metropolitan statistical areas (MSAs). Data are gathered from a representative sample of EDs, as well as from a group of participating medical examiners and coroners (ME/Cs). Estimates of drug-related morbidity (illness) are produced by collecting data on drug-related hospital ED visits, including the particular drug(s) involved, and assuming that changes in the drug-related ED visit estimates are indicators of similar changes in drug abuse trends in general.

The hospital EDs included in the DAWN data collection are selected through a probability sample. DAWN currently uses a stratified, single stage sample of general medical, non-Federal, short-stay hospitals with 24-hour EDs and collects data on all drug-related ED visits (i.e., episodes) within the sampled hospitals. The current sample was drawn in 1988 and with respect to particular analytic objectives and precision requirements. Although new hospitals are allowed a chance of selection through an annual sample maintenance process, most of the sampled units and efficiency of the sample design date back to the 1988 sample selection.

DAWN currently produces annual and semi-annual estimates of the number of drug-related ED visits (episodes) and drug mentions for the coterminous United States (i.e., excluding Alaska and Hawaii) as well as for 21 specific MSAs. These estimates are obtained through a probability sample of hospitals selected to be representative of each of the 21 MSAs, yielding about 470 responding hospitals as of 2000. The data obtained from these facilities are weighted to produce estimates of the total number of drug-related ED visits and drug mentions in each MSA. Some MSAs have lower relative standard errors (RSEs) for their estimates than others.

Among the participating hospitals are about 110 facilities that were selected to represent that portion of the coterminous United States that lies outside the 21 MSAs. These are referred to as “national panel” hospitals. In 2000, 83 of the 110 sampled national panel hospitals provided data for DAWN. The data obtained from these hospitals are weighted to produce estimates of the total number of drug mentions and drug-related visits in the remainder of the United States. These 110 hospitals are weighted to represent the 4,000 or so hospitals in the areas outside the 21 oversampled MSAs. For this reason, the average weight assigned to each of the national panel hospitals is about 50 (and sometimes higher). This means, for example, that a national panel hospital with 2 methamphetamine mentions in 2000 could contribute 100 (2x50) mentions to the national estimate for the year 2000. This issue caused considerable concern for analysts familiar with the DAWN data. The weighting issue is particularly problematic because DAWN seeks to measure rare events that may not be randomly distributed across the universe of hospitals. Adding more hospitals to the national panel would reduce their weights and improve the estimates they produce, but this would also increase the cost of data collection.

The overall estimate for the coterminous United States is derived by adding each of the MSA estimates to the national panel estimate. On balance, this approach yields an estimate with an acceptable level of statistical error (i.e., meeting or exceeding the precision target levels established for DAWN’s sample redesign in 1988—see “DAWN Sample Design and Estimation Procedures” [OAS, 1997]).

The redesign team’s constituent analyses suggested some support, particularly among the Federal agencies represented, for DAWN’s continued production of national estimates. The

primary users of these data would be Federal agencies interested in tracking overall, year-to-year trends in drug mentions or drug-related visits nationwide. In addition, SAMHSA's legislative mandate—although not explicit—implies that the agency will produce a count or estimate of the number of drug-related ED visits nationwide each year.

In March 2000, the redesign team's Technical Advisory Group (TAG) and the OAS Director's advisory group considered whether DAWN should continue to produce national estimates, as well as the optimal level of analysis for subnational estimation (e.g., MSA, state, county). Members of the advisory groups indicated an interest in national estimates but noted that they lacked confidence in the current DAWN estimates, which resulted in under-utilization of these data. Agencies expressing a particular interest in the national data were the Office of National Drug Control Policy (ONDCP) and the Drug Enforcement Administration (DEA). The major reasons expressed for lack of confidence in the data were the large weights assigned to many of the national panel facilities, and the substantial relative standard errors associated with estimates of emerging drugs such as methamphetamine. Overall, panelists encouraged continued work to improve the efficiency of the ED sample and estimation procedures. Subsequent discussions urged the redesign team to consider expanding the DAWN sample to provide truly national coverage (i.e., including Alaska and Hawaii), as distinct from the coverage of the coterminous United States.

Additional findings from the redesign's constituent analysis indicated that the majority of DAWN's users and applications are at the local level (city/county/MSA/state). Therefore, it was agreed that an alternative design must consider how best to generate locally relevant data. These considerations included—but were not limited to—the number, type, and distribution of areas for which DAWN provides data. Thus, geographic distribution of the sample also factored into the redesign process.

Given the age of the sample, the related efficiency issues and changes in the general population, OAS called for an evaluation of the current DAWN sample design. This request was motivated by the following specific concerns:

- Changes in the hospital and ED population over time.
- Changes in the drug abusing population and related analytic objectives.
- The current performance of the sample relative to MSA and drug specific estimates.

Hospital characteristics have changed considerably since the current sample was implemented in 1988, and especially with regard to characteristics that were used in the original sample design and stratification. The characteristics used in the original sample design included a hospital's annual count of ED visits and the presence or absence of an alcohol/chemical dependency unit or an outpatient department at the hospital in which the ED was located. The drug abusing population has also changed considerably with the emergence of new drugs, the geographic spread of existing drugs, and the demographics of drug users.

The statement of work for the DAWN sample redesign acknowledged that addressing these concerns could result in many changes to the current sample design. In particular, the statement of work called for new research into the following five general areas:

- Analytic objectives that could and should be achieved;
- Total sample size required for those objectives;
- National panel sample size required;
- List of MSAs specifically targeted; and
- Stratification of sampling units to be used.

The total sample size required and the national panel sample size required are a function of the analytic objectives. These objectives cover the estimates of interest, the precision required of these estimates, and the levels (nationally, by MSA) at which estimates are required. While these objectives tend to increase sample size as they grow more ambitious, stratification and optimal allocation can work to decrease the required sample sizes. The redesign team developed a sample design optimization process to satisfy these objectives simultaneously. This report presents the results of that process.

The redesign team carried out the sample design evaluation and research in two separate steps. First, the original sample design and its analytic objectives and precision requirements were documented. This was necessary because the original design, its required sample size, and its performance would serve as the standard for comparison with all alternative, new designs. Second, a sample design optimization process was developed that would minimize the sample size required to achieve a set of analytic objectives, given a particular sample design. This was accomplished by expressing the problem as a mathematical programming problem.

The combination of analytic objectives and sample design were referred to as "sample design scenarios." Various analytic objectives that were considered included estimation at the national and MSA level for as many as six different estimates (ED visits, total drug-related episodes, and episodes involving marijuana, cocaine, heroin, and/or methamphetamine) all with minimum RSE requirements. Sample designs included stratification by one or more of the following: MSA, ownership (public, non-public), and size (based on annual ED visits).

Using various combinations of analytic objectives, stratification criteria, and precision requirements, the redesign team obtained minimum required sample sizes for over 100 sample design scenarios. These results allowed the Substance Abuse and Mental Health Services Administration (SAMHSA) to review and consider the resources required by a set of analytic objectives as well as to interpolate the analytic objectives that could be met by a different level of resources. An iterative process was used to define parameters, generate scenarios, obtain solutions, and review results. New scenarios changed the number of targeted MSAs, the precision level required, the combination of estimates desired at different precision levels, etc. This iterative process was successful in defining the basic requirements of the new DAWN sample design. More detailed presentation of the sample design optimization approach and the results are provided throughout this report.

The proposed new design was obtained through iterations of specifying sample design scenarios and obtaining results from the sample design optimization process. At the end of this iterative process, OAS was able to identify a sample design that met its analytic goals within the

projected budget for the new implementation. The proposed new design has the following features:

- Requires an estimated 950 responding sample units;
- Includes 48 targeted MSAs;
- Provides national and MSA-specific estimates;
- Includes Alaska and Hawaii in the national estimate;
- Utilizes stratification by MSA, ownership, and size (ED visit volume);
- Provides RSEs <= 15% for national estimates;
- Provides RSEs <= 10% for MSA-specific estimates; and
- Includes estimates of total drug-related episodes, cocaine episodes, heroin episodes, and marijuana episodes at specified precision levels.

Overview of This Document

The remainder of this chapter provides more detail on the current DAWN sample design, the sample design optimization process, and the results from that process. The current sample design and its performance are described first. Next, the sample design parameters required for a redesign are reviewed. This is followed by a description of the models used to estimate counts of total episodes and drug-specific episodes at the hospital level for the entire hospital population. The sample design optimization process is then documented, along with the sample design scenarios and the results obtained from the optimization process. With this information as background, the proposed new design is then presented. The final section includes a number of sampling issues that were also considered and should be further evaluated as the new design is implemented.

CURRENT SAMPLE DESIGN AND PERFORMANCE

The original DAWN sample was drawn in the 1970s and consisted of approximately 800 sampled units in 30 or more MSAs. The sample degraded over time and, by the mid-1980s, was considered out of date due to considerable nonresponse and nonrandom replacement of original selections. In 1988, a new probability sample was drawn for DAWN consisting of 730 sampled units in 21 MSAs. This sample is still the basis for DAWN's estimation and is updated annually to allow new hospitals a chance of selection.

The current DAWN sample design consists of a stratified, single-stage cluster sample. The design uses 22 primary geographic strata with an additional 4 to 7 finer strata within each geographic stratum. The 22 geographic strata represent the 21 MSAs and the balance of the United States (the national panel). The stratification within each geographic area reflects the size of the hospitals (units with 80,000 or more annual ED visits were selected with certainty),

presence or absence of outpatient department or alcohol/chemical dependency units, and location within or outside the MSA's central city. Hospitals are selected with equal probability within stratum and all ED visits, episodes, and mentions are captured within sampled hospitals. To date, 730 hospitals have been selected, of which 578 were still eligible and 466 were responding in 2000. Table 3-1 shows the total eligible population size, total sample size, eligible sample size, and responding sample size within each of the DAWN MSAs.

Table 3-1. Population and Sample Sizes by MSA, 2000

MSA	Eligible Population	Eligible Sample	Responding Sample
Atlanta	32	19	15
Baltimore	21	21	21
Boston	45	25	22
Buffalo	10	10	8
Chicago	67	37	27
Dallas	31	20	11
Denver	14	14	9
Detroit	42	21	17
Los Angeles	86	46	34
Miami-Hialeah	24	18	16
Minneapolis-St. Paul	27	18	12
New Orleans	22	16	12
New York	78	35	31
Newark	25	17	16
Philadelphia	61	32	28
Phoenix	24	18	16
St. Louis	39	29	22
San Diego	20	20	18
San Francisco	19	19	16
Seattle	20	15	15
Washington, D.C.	31	18	17
National panel	3,950	110	83
Total United States	**4,688**	**578**	**466**

Current Performance

The current DAWN sample design was developed to satisfy certain precision requirements for national and MSA estimates (see Table 3-2). All precision requirements are expressed as RSE and with respect to estimates of total drug-related ED episodes.

Table 3-2. Precision Requirements for Original Sample Design

Estimate	RSE
National	6%
New York, Los Angeles, Chicago MSAs	6%
All other MSAs (excluding 5 MSAs w/ 100% sampling)	8%

Recent research indicates that some of these precision requirements are still being met by the current design; however, the performance varies by MSA and the precision for more specific estimates (such as cocaine episodes etc.) is lower for the national estimate and varies even more by MSA. Table 3-3 provides a summary of the performance of the current sample for certain estimates across MSAs in 1999.

Table 3-3. Current Performance (RSEs) by MSA, 1999

Estimate	National Estimate	Minimum (21 MSAs)	Mean (21 MSAs)	Maximum (21 MSAs)
Total episodes	7.3%	0.4%	9.8%	21.3%
Cocaine	9.0%	0.5%	13.0%	28.0%
Heroin	13.5%	0.6%	12.7%	28.8%
Marijuana	11.8%	0.4%	16.6%	41.7%

Note that the minimum RSE values are associated with the five MSAs within which all hospitals are selected with certainty.

SAMPLE DESIGN PARAMETERS REQUIRED FOR A REDESIGN

In order to design a new sample, the redesign team required specific information on the following four general parameter classes:

- **Level** at which estimates are required (e.g., national, regional, state, MSA, urban vs. suburban, etc.);
- Specific **estimates** for which minimum precision is required (e.g., episodes, cocaine mentions, methamphetamine mentions, etc.);
- **Precision** measure (RSE, power, etc.) and performance level required; and
- **Cost** implications at each level of contact, recruiting, or collection (e.g., at the MSA, hospital, and case levels).

These four parameters can occur in any combination. Any specific combination of parameters is referred to as a sample design scenario. Given decisions about the scenario preferred, a sample design can then be developed that either optimizes relative to these and

other constraints or that provides some balance or compromise between these competing constraints.

Given projected resources and constituent demands, SAMHSA provided the following guidance for these parameters:

- **Level –** DAWN must provide national estimates as well as MSA estimates. DAWN will not provide regional or state-level estimates, nor will it provide estimates for areas smaller than MSAs.

- **Estimates** – DAWN must provide a national estimate of the total number of drug-related ED episodes, as well as reasonably precise estimates of the total number of drug mentions for cocaine, heroin, and marijuana.[2]

- **Precision** – RSE levels of 20 percent, 15 percent, 10 percent, and 5 percent were initially selected for the national and MSA estimates, and for the four estimates listed above.

- **Cost** – The current cost and reimbursement model was provided by the current DAWN data collection contractor and was used to run a cost minimization model (described below).

GEOGRAPHIC COVERAGE

The number of targeted MSAs was identified early on as the principal driver in the estimated required minimum responding sample sizes obtained through the sample design optimization process. Given the importance of this particular design parameter, SAMHSA paid considerable attention to this detail, including a lengthy meeting in which SAMHSA and the redesign team reviewed maps, census data, and lists of targeted MSAs. The intention was to identify the particular list of MSAs to include in the final optimization runs and the proposed design.

Population was a key factor in the decision about which MSAs should be included in the expanded DAWN sample. The 21 MSAs currently represented in DAWN are among the largest metropolitan areas in the nation, but they are not the 21 largest MSAs. For example, Houston is the largest MSA not currently represented in DAWN, while estimates are provided for Buffalo, which ranked 50th among MSAs in population in 1999. In order to best reflect the distribution of the U.S. population while maximizing the overall geographic dispersion of DAWN MSAs, two general options were considered:

(1) Select MSAs in descending order of 1999 population, or

(2) Select MSAs in descending order of 1999 population within census division.

[2] DAWN provides estimates for many hundreds of drugs but precision constraints considered in the redesign process centered on the major drugs of abuse. Inclusion of precision constraints for methamphetamine and other less common though epidemiologically interesting substances drove required sample sizes beyond the resources available.

Population figures for 1999 were the most recent available at the time the sample scenarios were generated. It was understood that, immediately prior to implementation of the recommended design, the DAWN analytic contractor would consult the latest available census data, and any changes to the list of MSAs would be reviewed with SAMHSA.

In general, the objective was to maximize the percentage of the total U.S. population included in targeted areas while also obtaining considerable geographic dispersion of those areas. Several specific approaches were considered, in an effort to provide options that would allow more or less expansion depending on projected resource availability. Table 3-4 shows the MSAs grouped by the nine census divisions and ranked within division by their 1999 population. The columns then show which specific MSAs are included in the current design (21 MSAs); which MSAs would be included in each of three rank-by-population scenarios (the largest 36, 45, and 54 MSAs overall); and which MSAs would be included in each of three rank-within-census division scenarios (the largest 4, 5, or 6 MSAs in each of the nine Census Divisions). Because sufficient local interest in DAWN was shown in the current 21 MSAs, each of the options shown in Table 3-4 "protects" the 21 MSAs – that is, the options are included in all scenarios whether or not they meet the specific population ranking requirements of the overall approach.

The various combinations of metropolitan areas shown in Table 3-4 were then plotted on maps that were color-coded to correspond to each of the columns of the table. This exercise proved to be extremely valuable, because the maps provided a clear visual reference on which to base a final decision. Specifically, the maps illustrated that an expansion plan that added MSAs in descending order of population would, for the most part, add MSAs to regions where there was already significant coverage (typically the Pacific and South Atlantic divisions). On the other hand, expanding to include some number of MSAs in each census division ensured the inclusion of many of the most populous areas, along with some coverage in every major geographic area. Of particular importance was obtaining coverage of the East South Central division (which presently has no representation in DAWN), as well as enhancing coverage in the New England division and the rest of the central United States.

The decision was made to adopt an expansion strategy that would add MSAs by population within census division, while "protecting" each of the current 21 MSAs. The redesign team was instructed to proceed under the assumption that sufficient resources would be available to roughly double the number of MSAs currently represented in DAWN. The proposed expansion approach, shown in the next-to-last column in Table 3-4, calls for a total of 48 MSAs – the five largest in each of the nine census divisions (based on 1999 Census data), plus any of the 21 current MSAs falling outside the top 5 in their division. Methods used to arrive at this particular design decision are described in more detail here..

Table 3-4. Geographic Coverage Options Considered in DAWN Sample Redesign

CENSUS DIVISION & METROPOLITAN AREA	Current 21 MSAs (21)	36 Largest MSAs+ (38)	45 Largest MSAs+ (46)	54 Largest MSAs+ (54)	4 Largest MSAs in 9 Divisions+ (42)	Proposed Design: 5 Largest MSAs in 9 Divisions+ (48)	6 Largest MSAs in 9 Divisions+ (56)
NEW ENGLAND							
Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	✓	✓	✓	✓	✓	✓	✓
New Haven-Bridgeport-Stamford-Waterbury-Danbury, CT NECMA		✓	✓	✓	✓	✓	✓
Hartford, CT NECMA		✓		✓	✓	✓	✓
Providence-Warwick-Pawtucket, RI NECMA					✓	✓	✓
Springfield, MA NECMA						✓	✓
Portland, ME NECMA							✓
MIDDLE ATLANTIC							
New York, NY PMSA	✓	✓	✓	✓	✓	✓	✓
Philadelphia, PA-NJ PMSA	✓	✓	✓	✓	✓	✓	✓
Nassau-Suffolk, NY PMSA		✓	✓	✓	✓	✓	✓
Pittsburgh, PA MSA		✓	✓	✓	✓	✓	✓
Newark, NJ PMSA	✓	✓	✓	✓	✓	✓	✓
Bergen-Passaic, NJ PMSA			✓	✓			✓
Buffalo-Niagara Falls, NY MSA	✓	✓	✓	✓	✓	✓	✓
Middlesex - Somerset - Hunterdon, NJ PMSA				✓			
Monmouth - Ocean, NJ PMSA				✓			
EAST NORTH CENTRAL							
Chicago, IL PMSA	✓	✓	✓	✓	✓	✓	✓
Detroit, MI PMSA	✓	✓	✓	✓	✓	✓	✓
Cleveland-Lorain-Elyria, OH PMSA		✓	✓	✓	✓	✓	✓
Cincinnati, OH-KY-IN PMSA		✓	✓	✓	✓	✓	✓
Indianapolis, IN MSA			✓	✓		✓	✓
Columbus, OH MSA			✓	✓			✓
Milwaukee-Waukesha, WI PMSA			✓	✓			

Table 3-4. Geographic Coverage Options Considered in DAWN Sample Redesign (continued)

CENSUS DIVISION & METROPOLITAN AREA	Current 21 MSAs (21)	36 Largest MSAs+ (38)	45 Largest MSAs+ (46)	54 Largest MSAs+ (54)	4 Largest MSAs in 9 Divisions+ (42)	Proposed Design: 5 Largest MSAs in 9 Divisions+ (48)	6 Largest MSAs in 9 Divisions+ (56)
WEST NORTH CENTRAL							
Minneapolis-St. Paul, MN-WI MSA	✓	✓	✓	✓	✓	✓	✓
St. Louis, MO-IL MSA	✓	✓	✓	✓	✓	✓	✓
Kansas City, MO-KS MSA		✓	✓	✓	✓	✓	✓
Omaha, NE-IA MSA					✓	✓	✓
Wichita, KS MSA						✓	✓
Des Moines, IA MSA							✓
SOUTH ATLANTIC							
Washington, DC-MD-VA-WV PMSA	✓	✓	✓	✓	✓	✓	✓
Atlanta, GA MSA	✓	✓	✓	✓	✓	✓	✓
Baltimore, MD PMSA	✓	✓	✓	✓	✓	✓	✓
Tampa-St. Petersburg-Clearwater, FL MSA		✓	✓	✓	✓	✓	✓
Miami, FL PMSA	✓	✓	✓	✓	✓	✓	✓
Norfolk-Virginia Beach-Newport News, VA-NC MSA		✓	✓	✓			✓
Fort Lauderdale, FL PMSA			✓	✓			
Orlando, FL MSA			✓	✓			
Charlotte-Gastonia-Rock Hill, NC-SC MSA			✓	✓			
Greensboro - Winston-Salem - High Point, NC MSA				✓			
Raleigh - Durham - Chapel Hill, NC MSA				✓			
EAST SOUTH CENTRAL							
Nashville, TN MSA				✓	✓	✓	✓
Louisville, KY-IN MSA					✓	✓	✓
Birmingham, AL MSA					✓	✓	✓
Knoxville, TN MSA					✓	✓	✓
Mobile, AL MSA						✓	✓
Johnson City - Kingsport - Bristol, TN-VA MSA							✓

Table 3-4. Geographic Coverage Options Considered in DAWN Sample Redesign (continued)

CENSUS DIVISION & METROPOLITAN AREA	Current 21 MSAs (21)	36 Largest MSAs+ (38)	45 Largest MSAs+ (46)	54 Largest MSAs+ (54)	4 Largest MSAs in 9 Divisions+ (42)	Proposed Design: 5 Largest MSAs in 9 Divisions+ (48)	6 Largest MSAs in 9 Divisions+ (56)
WEST SOUTH CENTRAL							
Houston, TX PMSA		✓	✓	✓	✓	✓	✓
Dallas, TX PMSA	✓	✓	✓	✓	✓	✓	✓
Fort Worth-Arlington, TX PMSA		✓	✓	✓	✓	✓	✓
San Antonio, TX MSA		✓	✓	✓	✓	✓	✓
New Orleans, LA MSA	✓	✓	✓	✓	✓	✓	✓
Austin - San Marcos, TX MSA				✓			✓
MOUNTAIN							
Phoenix-Mesa, AZ MSA	✓	✓	✓	✓	✓	✓	✓
Denver, CO PMSA	✓	✓	✓	✓	✓	✓	✓
Las Vegas, NV-AZ MSA			✓	✓	✓	✓	✓
Salt Lake City-Ogden, UT MSA				✓	✓	✓	✓
Tucson, AZ MSA						✓	✓
Albuquerque, NM MSA							✓
PACIFIC							
Los Angeles-Long Beach, CA PMSA	✓	✓	✓	✓	✓	✓	✓
Riverside-San Bernardino, CA PMSA		✓	✓	✓	✓	✓	✓
San Diego, CA MSA	✓	✓	✓	✓	✓	✓	✓
Orange County, CA PMSA		✓	✓	✓	✓	✓	✓
Oakland, CA PMSA		✓	✓	✓		✓	✓
Seattle-Bellevue-Everett, WA PMSA	✓	✓	✓	✓	✓	✓	✓
Portland-Vancouver, OR-WA PMSA		✓	✓	✓			
San Francisco, CA PMSA	✓	✓	✓	✓	✓	✓	✓
San Jose, CA PMSA		✓	✓	✓			
Sacramento, CA PMSA		✓	✓	✓			

MODELING ED POPULATION DATA

To assign facilities to strata, it was necessary to model population data – that is, to make some determination about the size of each eligible facility, as expressed not only in total ED visits but also in the number of heroin, cocaine, marijuana, and methamphetamine episodes seen in each facility. While total ED visit data are available for all eligible facilities from secondary sources, DAWN is the only source of information on drug-related episodes. Thus, modeling was required to estimate the total number of drug-related and drug-specific episodes for facilities not currently participating in DAWN.

To accomplish this, each eligible record (facility) on the DAWN frame was assigned a reported annual ED visits count, which was based on the DAWN and American Hospital Association (AHA) survey data and consistent with the methodology used for DAWN benchmark adjustment. Each eligible record was also assigned an estimate of the number of DAWN episodes for the four major drug groups (marijuana, cocaine, heroin, and methamphetamine) and in total. These annual estimates were modeled (for eligible units not in the DAWN sample or not responding) based on the relationship identified between these variables and annual ED visits, within region and ownership, as follows:

$$X_{hijk} = MAX\left(0, B_{0hij} + B_{1hij} V_k\right)$$

Where

Xhijk = the annual estimate of episodes for region h, ownership class i, drug j, unit k
B0hij = the model intercept term for region h, ownership class i, drug j
B1hij = the model slope parameter for region h, ownership class i, drug j
Vk = annual ED visits for unit k.

SAS PROC REG was used to obtain the model parameters.

These estimated annual counts were the basis for the final stage of the multivariate sample design optimization. It was important in this regard that these estimates be calculated as the predicted value plus or minus some standardized residual. Westat's WESDECK hot-deck imputation software was used to select donors that would be used to add or subtract a standardized residual to the predicted annual estimate of episodes given above. (Although WESDECK is Westat's proprietary software, hot-deck imputation is a well-established statistical procedure.)

For each eligible unit on the frame and not reporting, a modified annual estimate of episodes was calculated as follows:

$$Y'_{hijk} = MAX\left(0, X_{hijk} \frac{Y_{hijD(k)}}{X_{hijD(k)}}\right)$$

Where

Y'hijk	=	the final estimated annual episodes for region h, ownership class i, drug j, and unit k
Xhijk	=	the model estimated annual episodes for region h, ownership class i, drug j, unit k
YhijD(k)	=	the reported annual episodes for region h, ownership class i, drug j, and donor for k
XhijD(k)	=	the model estimated annual episodes for region h, ownership class i, drug j, donor for k

A note is in order regarding the above methodology. The relationship between ED visits and drug-specific episodes is not especially strong, even within region and ownership. Models were somewhat imprecise and as a result contributed variance to the estimated drug-specific episodes. It may be possible, given additional resources, to obtain more precise models that in turn would result in smaller required sample sizes. This is uncertain, however, given the variability observed in the DAWN data and the fact that the process had already made use of the most significant quantitative variable (ED visits) available for the entire population. The amount of reduction in sample sizes would be directly related to the success of the modeling and was therefore difficult to speculate. The improved modeling task also competed with other sample redesign tasks. Concerns such as these, along with competition for resources among redesign activities, SAMHSA's experience with modeling state-level estimates for the NHSDA, and their resulting concerns about modeling at the hospital level for DAWN led to the decision not to develop these models further.

SAMPLE DESIGN OPTIMIZATION PROCESS

Sample design optimization is trivial in the univariate case, in that whether calculating the sample size required for specified precision or calculating the precision given by a specific sample size, one simply solves for one unknown in an algebraic equation. For example, under simple random sampling, the precision obtained by a sample of size *n* is calculated as follows:

$$\sigma^2_{\bar{x},SRS} = \frac{S_x^2}{n}\frac{N-n}{N} = \frac{S_x^2}{n}(1-f)$$

Where

$$S_x^2 = \frac{\sum_{i=1}^{N}\left(X_i - \bar{X}\right)^2}{N-1}$$

$$f = \frac{n}{N}$$

Similarly, under stratified random sampling, an explicit solution for the optimal allocation of *n* sampling units to *h* strata is available as follows:

$$n_h = n \frac{N_h S_h / \sqrt{C_h}}{\sum N_h S_h / \sqrt{C_h}}$$

In the multivariate case, however, no single equation is either available or appropriate. In this case, a mathematical programming approach is required.

Mathematical programming problems have the following three characteristics:

- Decision variables – Variables allowed to take on any values, subject to certain constraints
- Objective function – A function of the decision variables to be maximized or minimized
- Constraints – Explicit constraints on the decision variables themselves or implicit constraints on other functions of the decision variables

In general, the decision variables are quantities that are allowed to move about, as needed, in order to solve all other aspects of the mathematical programming problem. Sometimes the decision variables are subject to certain reality or practicality-driven constraints. For example, in manufacturing, the decision variables could be the number of units of a particular product to produce. The objective function is a function of the decision variables and can be either linear on nonlinear. The nature of the problem often requires that the objective function be maximized, minimized, or set to a particular value. For example, in manufacturing, the objective function may be to maximize the profit from producing a given lot of units. The constraints are often in terms of values that the decision variables must respect but can also be another function of the decision variables. For example, in the manufacturing problem negative numbers of units would not be allowed, there may be a minimum number of units of each product that must be produced, and the common resources consumed may be a function of the number of units of more than one product and must be kept at or below a particular level. The particular mathematical programming problems for the DAWN sample redesign are presented below. SAS PROC NLP, part of the SAS OR library, was used to solve these problems with the Quasi-Newton method.

MULTIVARIATE SAMPLE DESIGN OPTIMIZATION

The DAWN sample design optimization problem (the sample size minimization version) can be expressed in the following mathematical programming notation:

Minimize:

$$T = \sum_{i=1}^{L} \sum_{j=1}^{H_i} n_{ij}$$

Subject to:

1) $2 \leq n_{ij} \leq N_{ij}$
2) $RSE_i(x_k) \leq T_i(x_k)$

Where:

i	=	the primary stratum index (e.g., MSA).
j	=	the secondary stratum index (e.g., ownership X size).
L	=	the number of primary strata (# of specifically targeted MSAs + 1)
H_i	=	the number of secondary strata in primary stratum i
n_{ij}	=	the sample size in stratum ij (these are the decision variables)
N_{ij}	=	the population size in stratum ij
$RSE_i(x_k)$	=	the relative standard error of estimate k in stratum i
$T_i(x_k)$	=	the target relative standard error of estimate k in stratum i

and the relative standard error is expressed as follows:

$$RSE_i(x_k) = \frac{\sqrt{\sum_{j=1}^{H_i} \frac{W_j^2 S_j^2 (1 - f_j)}{n_j}}}{\overline{x_{ik}}} \text{ for MSA estimates and}$$

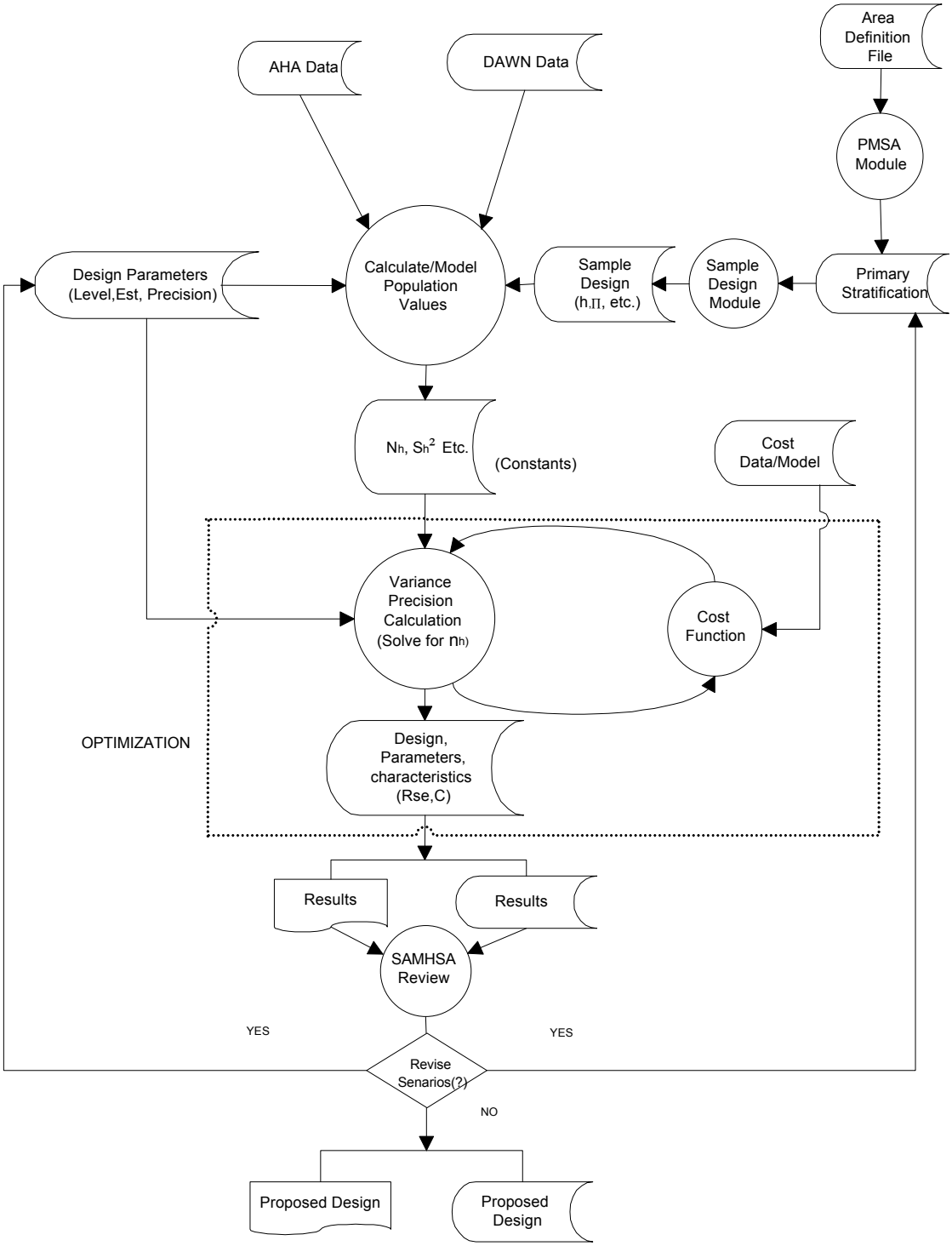
$$RSE_N(x_k) = \frac{\sqrt{\sum_{i=1}^{L} \sum_{j=1}^{H_i} \frac{W_{ij}^2 S_{ij}^2 (1 - f_{ij})}{n_{ij}}}}{\overline{x_{Nk}}} \text{ for the national estimates.}$$

OVERALL SAMPLE DESIGN OPTIMIZATION PROCESS

The sample design optimization process developed for DAWN is shown in the flow chart in Figure 3-1. The sample design optimization process consisted of the following steps:

- Determine primary stratification based on specified MSAs.

Figure 3-1. Dawn Sample Design Scenarios Evaluation System



- Determine secondary stratification based on other sample design variables (e.g., ownership, size.)
- Model and calculate population values from AHA and DAWN data, by sampling stratum.
- Solve for minimum sample size required to satisfy all constraints.
- Record and report scenario and results.
- Provide results for SAMHSA's review.

The primary stratification was determined based on the MSAs targeted in a specific scenario. Secondary stratification was determined based on the other stratification variables used in a specific scenario. For example, stratification by hospital ownership (public, non-public) and size (based on annual ED visits) were used and identified as being considerably more effective than stratification by MSA or MSA and ownership alone. Up to four size-specific strata were formed within each MSA and ownership category. The stratification by size depended on the number of sampling units available within each MSA and ownership category, as shown in Table 3-5.

Table 3-5. Stratification by Size

Number of Sampling Units Available Within MSA	Number of Size Strata
0...3	1
4	2
5	2
6	2
7	2
8 or more	4

The sampling units were sorted in descending order of the annual measure of ED visits and split into strata with an even number of sampling units. When this was not possible the odd number of units was simply assigned to the latter strata.

Given the stratification and modeled and calculated population values described above, SAS PROC NLP was used to solve for the minimum responding sample size required for a given sample design scenario to satisfy all constraints, as expressed above. These results were recorded in a scenario log, which is the basis for all tables included in this report.

SAMPLE DESIGN SCENARIOS AND RESULTS

One of DAWN's greatest analytical strengths is its ability to say something about individual, local areas. The national estimate available from DAWN is not the system's primary analytic objective, but it is useful for putting individual MSA estimates in perspective, especially changes in the trends of such estimates. The MSA analytic objective is the main driving factor behind the minimum required responding sample sizes discussed here. It is therefore useful to compare the sample sizes for scenarios requiring MSA estimates to the sample sizes that would be required to produce a national estimate exclusively. This, in turn, helps put in perspective the sample sizes that are required within the national panel to yield a national estimate with specified precision, given the sample sizes allocated to the targeted MSAs.

NATIONAL ESTIMATE-ONLY SCENARIOS

Table 3-6 provides the sample sizes required for various scenarios involving a national estimate only. For example, 91 sampled units are required to produce a national estimate of ED visits with an RSE of 10 percent under a simple random sample design. By contrast, 202 sampled units are required to produce a national estimate of total episodes with an RSE of 10 percent under a stratified random sample design, where the stratification was by ownership and size. Expanding that scenario to include estimates for cocaine episodes, heroin episodes, and marijuana episodes with RSEs of 10 percent leads to a required sample size of 544. Finally, 660 sampled units are required to produce a national estimate of total episodes with an RSE of 5 percent.

Table 3-6. National Estimate-Only Scenarios

Scenario	Sample Size
Optimized, SRS, 10% RSE on ED visits	91
Optimized, Stratified SRS, 10% RSE on total episodes	202
Optimized, Stratified SRS, 10% RSE on total episodes, Cocaine, Heroin, Marijuana	544
Optimized, Stratified SRS, 5% RSE on total episodes	660

EARLY ROUNDS OF SCENARIOS

As described above, a sample design scenario represents the combination of the **level** at which estimates are required, the specific **estimates** that are required, and the **precision** level that is required for those estimates. The sample design scenarios that were run through the optimization process included the following choices for each of these parameter classes:

Level:
1) National and the current 21 DAWN MSAs
2) National and the top 21 MSAs in 1999
3) National and top 27 MSAs in 1999
4) National and the top 50 MSAs in 1999

Estimates:
1) Total annual ED visits
2) Total annual Marijuana/Hashish episodes
3) Total annual Cocaine episodes
4) Total annual Heroin/Morphine episodes
5) Total annual Methamphetamine/Speed episodes

Precision:
1) RSEs = 5%
2) RSEs = 10%

The scenario results obtained were in line with the redesign team's expectations and the current DAWN sample design. Differences between the results are direct consequences of changes in targeted areas (MSAs), the number of estimates included in the optimization (ED visits, episodes for the 4 top drug categories), the relative standard error constraints applied (RSEs), and whether RSE constraints were applied specifically to the national panel. The results range from a minimum required sample size of 91 hospitals for a national estimate of ED visits only with an RSE <= 10%, to a maximum required sample size of 2,386 hospitals for estimates for the nation as well as each of the top 50 MSAs with RSEs <= 5% for all five estimates (ED visits and the 4 drug categories). The results are described in more detail below.

Table 3-7 shows a select few sample scenarios and the responding sample sizes needed to achieve either 10 percent or 5 percent RSEs on the desired estimates.

Table 3-7. Actual or Minimum Required Responding Sample Size by Design and MSA Precision Level

Design	RSE = 10%	RSE = 5%
Current (21 MSAs, ED visits and total episodes)	**488**	**n/a**
Optimized (21 MSAs, ED visits and total episodes)	459	609
Optimized (21 MSAs, 5 estimates)	899	1,614
Optimized (Top 27 MSAs, 5 estimates)	928	1,591
Optimized (48 MSAs, 4 estimates)	**950**	**n/a**
Optimized (Top 50 MSAs, 5 estimates)	1,148	1,723

The first and fifth rows of this table represent the current design and the proposed new design, respectively. The current sample design obtains reasonably precise national and MSA estimates of ED visits and total drug-related episodes with a responding sample size of approximately 488 sampled units. The current RSEs for the national estimates are around 10 percent. The results by MSA and specific drug vary under the current design, with the RSEs of estimates for some MSAs and some specific drugs (e.g., methamphetamine) being far in excess of 10 percent (discussed in detail below).

The minimum required responding sample sizes obtained from the sample design optimization process ranged from 459 sampled units for a minimum MSA RSE of 10 percent on ED visits and total drug-related episodes to 1,723 sampled units for a minimum MSA RSE of 5 percent on ED visits and cocaine, heroin, marijuana, and methamphetamine episodes. Note that the first and second rows of the table are not exactly comparable. This is due to the fact that the actual achieved MSA RSEs for the current design vary considerably, while the expected MSA RSEs for the optimized design are at or below the given RSE level for *all* MSAs.

The minimum required sample sizes increase as additional estimates or additional MSAs are added to the sample design scenarios. For example, the third row of Table 3-7 shows the minimum required sample sizes for minimum RSEs of 10 percent or 5 percent in the current 21 MSAs for each of five estimates of interest (ED visits, cocaine episodes, heroin episodes, marijuana episodes, methamphetamine episodes). The fifth row shows the minimum required sample sizes for the proposed design, with minimum MSA RSEs of 10 percent for four estimates of interest (total drug-related episodes, cocaine episodes, heroin episodes, and marijuana episodes). The evolution and selection of these combinations of requirements are detailed in the sections that follow.

Next, Table 3-8 shows the minimum sample sizes required by stratum for several different sets of estimates within five selected MSAs. This table is illustrative of the output generated for each different list of candidate MSAs given desired estimates and precision constraints. The estimates shown here include ED visits only, ED visits and all four major drug categories, ED visits and three of the major drug categories (less methamphetamine), and each of the four major drug categories separately. Table 3-8 shows RSEs =10 percent. Similar tables were produced for RSEs = 5%. The purpose of this table is to show the differences in minimum required sample sizes, at the finest stratification level, for various subsets of estimates. Joint review of a considerable number of such tables by the redesign team and OAS informed the final decisions regarding the scope and composition of the proposed new sample design.

Table 3-8. Minimum Sample Sizes Required by Stratum and Estimates, Selected MSAs

Stratified by MSA, ownership, and size. RSE constraint =10%.

		Ownership = Public				Ownership = Private				
		Size group				Size group				
Metropolitan Area	**Variables**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**TOTALS**
LOS ANGELES-LONG BEACH, CA MSA	Strata population count	3	3	0	0	20	20	20	21	87
	ED visits	2	2			2	2	2	2	12.00
	ED visits & 4 Drugs	3	2.89			8.15	11.05	5.1	2	32.19
	ED visits & 3 Drugs	3	3			5.91	4.56	5.94	2	24.41
	Cocaine	3	3			5.91	4.56	5.94	2	24.41
	Heroin	3	2.49			5.5	4.34	2.73	2	20.06
	Marijuana/hashish	3	3			5.18	3.7	3.82	2	20.70
	Methamphetamine/speed	3	2.44			8.27	11.23	5.18	2	32.12
NEW YORK, NY MSA	Strata population count	3	3	3	4	16	16	16	17	78
	ED visits	2	2	2	2	2	2	2	2	16.00
	ED visits & 4 Drugs	2	2	2	2.46	11.2	16	8.55	7.72	51.93
	ED visits & 3 Drugs	2	2	2	3.15	9.7	16	3.75	9.31	47.91
	Cocaine	2	2	2	3.69	7.33	16	4.21	9.92	47.15
	Heroin	2	2	2	2	11.92	16	2.64	7.66	46.22
	Marijuana/hashish	2	2	2	2.63	5.09	16	5.19	5.35	40.26
	Methamphetamine/speed	2	2	2	2	11.89	16	9.54	4.71	50.14
CHICAGO, IL MSA	Strata population count	3	0	0	0	20	21	21	21	86
	ED visits	2				2.8	2	2	2	10.80
	ED visits & 4 Drugs	3				20	16.17	14.52	4.07	57.76
	ED visits & 3 Drugs	3				20	16.21	8.17	6.34	53.72
	Cocaine	3				20	13.81	9.11	7	52.92
	Heroin	3				14.53	21	3.11	2.25	43.89
	Marijuana/hashish	2.27				20	12.43	9.77	7.61	52.08
	Methamphetamine/speed	3				20	4.7	17.39	3.96	49.05
PHILADELPHIA, PA-NJ MSA	Strata population count	0	0	0	0	15	16	16	16	63
	ED visits					2.2	2	2	2	8.20
	ED visits & 4 Drugs					15	5.78	11.65	6.35	38.78
	ED visits & 3 Drugs					15	3.94	2.9	8.4	30.24
	Cocaine					15	3.62	2.73	8.83	30.18
	Heroin					15	5.53	2	4.3	26.83
	Marijuana/hashish					15	3.87	3.47	2	24.34
	Methamphetamine/speed					15	5.96	12.9	3.52	37.38
WASHINGTON, DC-MD-VA-WV MSA	Strata population count	1	0	0	0	9	9	9	10	38
	ED visits	1				2	2	2	2	9.00
	ED visits & 4 Drugs	1				8.88	9	7.24	2.35	28.47
	ED visits & 3 Drugs	1				9	4.91	4.8	4.07	23.78
	Cocaine	1				9	4.55	3.16	3.72	21.43
	Heroin	1				6.84	4.8	2	2	16.64
	Marijuana/hashish	1				9	4.91	4.8	4.07	23.78
	Methamphetamine/speed	1				5.17	9	8.92	2.44	26.53

LAST ROUND OF SCENARIOS

The last round of optimization scenarios focused on four different lists of MSAs and three different combinations of national and MSA-specific RSE constraints. The four different lists of MSAs were as follows:

1. Top 36 MSAs by population, plus any of current 21 otherwise excluded (38 total)

2. Top 4 MSAs in each of 9 census divisions, plus any of the current 21 otherwise excluded (42 total)

3. Top 45 MSAs by population, plus any of current 21 otherwise excluded (46 total)

4. Top 5 MSAs in each of 9 census divisions, plus any of the current 21 otherwise excluded (48 total)

The three different combinations of national and MSA-specific RSE constraints were as follows:

1. Twenty percent RSEs for national estimates, 10 percent RSEs for MSA estimates

2. Fifteen percent RSEs for national estimates, 10 percent RSEs for MSA estimates

3. Ten percent RSEs for national estimates, 10 percent RSEs for MSA estimates

The estimated minimum required responding sample sizes for these different scenarios are shown in Table 3-9.

Table 3-9. Estimated Minimum Required Responding Sample Sizes for Last Round of Scenarios (includes national panel sample size)

	RSE Constraints National/MSA		
Scenario	20% / 10%	15% / 10%	10% / 10%
Top 36+ (38 total)	825	868	980
Top 4 in 9+ (42 total)	861	901	1,005
Top 45+ (46 total)	909	946	1,046
Top 5 in 9+ (48 total)	911	950	1,051

The sample size required in the national panel for these different scenarios are shown in Table 3-10.

Table 3-10. Estimated National Panel Sample Sizes for Last Round of Scenarios

	RSE Constraints National/MSA		
Scenario	20% / 10%	15% / 10%	10% / 10%
Top 36+ (38 total)	64	107	218
Top 4 in 9+ (42 total)	60	100	204
Top 45+ (46 total)	57	95	194
Top 5 in 9+ (48 total)	59	97	199

It was through review of these estimated required responding sample sizes, including the national panel sample sizes, and the actual expected RSEs obtained through these sample sizes that the proposed new design was decided upon. The proposed new design includes the top 5 MSAs in each of the 9 census divisions, plus any of the current 21 MSAs otherwise excluded (48 MSAs total), with national estimate RSE constraints of 15 percent and MSA estimate RSE constraints of 10 percent. This design entails an estimated sample size of 950 responding units, of which 97 are allocated to the national panel. It was felt that this design best balanced the desire to expand the sample's geographic coverage and improve the precision of the estimates obtained while considering the resources needed to recruit, retain, and manage a data system of this size.

As has been discussed earlier, the actual expected RSE will be less than or equal to the RSE constraints. Table 3-11 presents the actual expected RSEs for the proposed new design.

Table 3-11. Actual Expected RSEs for the Proposed New Design

Estimate	National estimate	Mean for 48 MSA estimates	MAX for MSA estimates
Total episodes	9.0%	3.9%	10.0%
Cocaine episodes	13.0%	6.3%	10.0%
Heroin episodes	15.0%	7.2%	10.0%
Marijuana episodes	15.0%	7.8%	10.0%

The RSEs in Table 3-11 compare favorably to the RSEs achieved by the current design (see Table 3-3). The mean MSA RSEs for the proposed new design are roughly half those of the MSAs included in the current design. The maximum RSEs are considerably lower for the new design. The national estimate RSEs for the new design are slightly higher than those of the current design. Increasing the national panel (and hence total) sample size by 100 responding units would bring the national estimate RSEs for the new design to or below the level of the current design.

COST-BASED OPTIMIZATION

All of the scenarios and optimization runs described above involved the relatively naive assumption that all sampling units were of equal cost. OAS used the estimated minimum required responding sample sizes as a proxy for cost, relative to the current responding sample size and costs. However, it may cost more or less to recruit one facility relative to another, to retain that facility, and to compensate that facility for participation in DAWN. Moreover, actual costs may be different under the new design if new recruitment, retention, and/or reimbursement strategies are developed. A fully-informed cost-based optimization for the new implementation would require that the direct reimbursement model be known for the new design and implementation. However, the redesign team was not tasked with developing that new reimbursement model; this task was explicitly assigned to the data collection contractor that would be responsible for implementing the new sample. Therefore, for the purpose of running a final cost-based optimization to compare to the naive model, the current reimbursement model was used.

Current Reimbursement Model. The current direct reimbursement model is as follows:

$$C_{ij} = F\left(\overline{B}_{0ij} + \overline{B}_{1ij}\overline{x}_{ij} + \overline{B}_{2ij}\overline{y}_{ij}\right)Z_{ij}$$

Where

$\overline{x_{ij}}$ = the mean annual ED visits within stratum ij (i=MSA/national panel, j=ownership/size stratum)

$\overline{y_{ij}}$ = the mean annual total episodes within stratum ij

$\overline{B_{0ij}}$ = the mean minimum compensation level within stratum ij

$\overline{B_{1ij}}$ = the mean ED visits coefficient from the current cost model within stratum ij

$\overline{B_{2ij}}$ = the mean Total Episodes coefficient from the current cost model within stratum ij

F = 0.90 (this is the factor that gives SAMHSA room to negotiate)

Z = the cost of living adjustment (COLA) from the current cost model, for primary stratum i

The direct reimbursement model coefficients varied by whether a unit was located in a central city or not, as follows in Table 3-12:

Table 3-12. Direct Reimbursement Model Coefficients by Facility Location.

Coefficient	In a Central City	Not in a central city
B0	45.0	313.7
B1	0.066	0.035
B2	1.879	1.735

Cost-Minimization Run. The sample design optimization problem was changed from one that minimizes sample size to one that minimizes cost. The cost was limited to the current reimbursement protocol. Another optimization problem was run for the proposed design only. The

intention was to compare the sample allocation results to those previously obtained under the simpler sample size minimization problem.

A cost minimization version of the sample design optimization problem can be stated as follows:

Minimize:

$$T = \sum_{i=1}^{L} \sum_{j=1}^{H_i} c_{ij} n_{ij}$$

Subject to:

1) $2 \leq n_{ij} \leq N_{ij}$
2) $RSE_i(x_k) \leq T_i(x_k)$

Where:

i	=	the primary stratum index (e.g., MSA).
j	=	the secondary stratum index (e.g., ownership X size).
L	=	the number of primary strata (# of specifically targeted MSAs + 1)
H_i	=	the number of secondary strata in primary stratum i
c_{ij}	=	the average cost of sampling a unit in stratum ij (see below)
n_{ij}	=	the sample size in stratum ij (these are the decision variables)
N_{ij}	=	the population size in stratum ij
$RSE_i(x_k)$	=	the relative standard error of estimate k in stratum i
$T_i(x_k)$	=	the target relative standard error of estimate k in stratum i

and the relative standard error is expressed as follows:

$$RSE_i(x_k) = \frac{\sqrt{\sum_{j=1}^{H_i} \frac{W_j^2 S_j^2 (1 - f_j)}{n_j}}}{\overline{x_{ik}}}$$

$$RSE_N(x_k) = \frac{\sqrt{\sum_{i=1}^{L} \sum_{j=1}^{H_i} \frac{W_{ij}^2 S_{ij}^2 (1 - f_{ij})}{n_{ij}}}}{\overline{x_{Nk}}}$$

Cost Data. Since the coefficients for the direct reimbursement model were not constant within the strata proposed for the new sample design, an average annual direct reimbursement cost for each unit within a particular stratum was calculated as follows:

$$C_{ij} = F\left(\overline{B_{0ij}} + \overline{B_{1ij}}\,\overline{x_{ij}} + \overline{B_{2ij}}\,\overline{y_{ij}}\right) Z_{ij}$$

Where

$\overline{x_{ij}}$ = the mean annual ED visits within stratum ij

$\overline{y_{ij}}$ = the mean annual total episodes within stratum ij

$\overline{B_{0ij}}$ = the mean minimum compensation level within stratum ij

$\overline{B_{1ij}}$ = the mean ED visits coefficient from the current cost model within stratum ij

$\overline{B_{2ij}}$ = the mean Total Episodes coefficient from the current cost model within stratum ij

Evaluation. Only very minor differences in the sample allocation and estimated reimbursement costs were found between the sample size minimization and cost minimization runs. The differences in required responding sample size and estimated direct reimbursement were as shown in Table 3-13.

Table 3-13. Cost-Minimization Results

Optimization problem	Required responding sample size	Estimated direct reimbursement
Minimize sample size	949	$3,361,490.41
Minimize cost	961	$3,334,997.53

Comparison of the sample size-minimization results with the cost-minimization results yielded the following observations:

1. The difference in sample size between the two approaches is a total of 12 units.

2. The difference in estimated cost between the two approaches is a total of $26,492.88.

3. The COLA term does not affect the allocation. Identical results were obtained using uniform COLAs of 1.0 compared with the COLAs obtained from the 2000 *Statistical Abstract of the United States*.

4. The allocation at the MSA level changed only very slightly between the sample size-minimization and cost-minimization approaches.

5. The allocation across strata within a given MSA changed slightly between the sample size-minimization and cost-minimization approaches, indicating that the direct reimbursement model coefficients are having only a minor effect on the allocation.

These observations may or may not hold under a different cost or direct reimbursement model. It is likely that these observations will hold under any similar models, as the driving factor at the MSA level is the MSA precision constraint, whenever these constraints are more stringent than what is required at the national level. Under other sample design circumstances, cost-minimization results can be considerably different from sample size-minimization results.

OTHER SAMPLING ISSUES

This section lists a number of statistical issues that were considered, at various levels of detail, in addition to the DAWN sample redesign analysis. Some of these issues have been discussed in the past, some were discussed in DAWN management meetings, and some are appropriate to consider now given the DAWN redesign in general. Note that resolution of many of these issues was beyond the scope of the redesign contract and must be handled by the analytic contractor as the new design is implemented. The purpose of this section is to document the issues that were considered and to identify areas where specific approaches will need to be developed.

These issues are presented in the likely order of implementation. For example, issues such as overlap control and the merger/demerger protocol should be resolved prior to drawing a new sample. Issues such as adjustments for missing data and variance estimation should be resolved before estimates are required from the new sample. Other issues, such as sample maintenance and panel rotation and phasing-in strategies are ongoing issues.

Overlap Control

The redesign team recommended that overlap control be considered as part of the DAWN sample redesign activities and researched this option. Overlap control is often considered as a recruitment cost-reduction technique when an ongoing study implements a new sample design but continues to use the same kind of sampling units (e.g., hospitals). Versatile techniques exist that can maximize the expected overlap between the old and new samples while maintaining the desired statistical features of the new sample design. These techniques become increasingly complicated as the measures of size, stratification, and definition of sampling units change from the old sample design to the new sample design.

This section presents the results of the redesign team's research and the resulting recommendation. The research indicated that overlap control can not be implemented exactly (i.e., optimally) due to the size of the overlap control problem. There are also cases of births, deaths, mergers, and demergers in which the concept of overlap may be difficult to define. There are techniques for approximate overlap control that could be applied in the problematic strata.[3] Given the challenges faced, it was recommended that overlap control be implemented only in the national panel in the new DAWN sample design. If overlap control is desired in other strata, careful study of those strata is recommended to ensure that the new sample is properly implemented.

In order to perform overlap control correctly, it is necessary to know the joint probabilities of selection from any previous rounds of overlap control. Usually, strata are selected independently, but if an overlap control selection method is used, the independence of strata assumption can be violated. Because the current design (developed in 1988) reported using overlap control

[3] See, for example, (1999). *The maximization and minimization of sample overlap problems: A half century of results*; or Chowdhury, Chu, and Kaufman. (2000). Minimizing overlap in NCES surveys, *2000 ASA Proceedings of JSM, Section on Survey Research.*

procedures with a previous design (i.e., the 1970's design), it is necessary to obtain the joint probabilities of the 1970's – 1988 design if overlap control procedures are to be used in selecting the new DAWN sample.

SAMHSA provided historical documents on their methods of sample selection from the previous design. SAMHSA identified the 1988 internal document "Development and Implementation of a Probability Sample Design for the Drug Abuse Warning Network" as the authoritative account to be followed. This document includes a section that describes the overlap control that was performed as part of the 1988 design. Overlap control was implemented in only three areas and via the Keyfitz procedure: New York, Chicago, and in strata 8 and 9 of the national panel. In all other areas and strata, the selections in the 1988 sample were independent of the 1970's design. If overlap control is performed again in any of the strata in New York, Chicago, or the national panel, then the previous overlap control must be taken into account.

It was recommended that if SAMHSA desires to employ overlap control between the proposed sample design and the 1988 sample, then the conditional probabilities used in the 1988 overlap control must be used as part of the new overlap control. It appears that in most DAWN areas, no overlap control was performed in the 1988 sample. Exact or approximate overlap control is therefore feasible for the proposed new design. The benefit of this overlap will depend on the number of units in common between the proposed new design and the 1988 sample, as well as the differences in the relevant recruitment costs. Due to the large number of sampled units within each targeted MSA, the inflation required for nonresponse, and the likely possibility of implementing a two-phase sampling approach (described below), it is expected that the opportunities for overlap control will be greatest in the national panel, and that the differences in the relevant recruitment costs will be the most significant factor in evaluating the benefits of this technique.

Two-Phase Sampling

A two-phase sampling approach could be used to build a better sampling frame for DAWN. In the first phase, a larger-than-needed sample of hospitals would be drawn, and counts of DAWN episodes could be obtained for a few months within each of those hospitals. The second phase would then use this information to derive new and more accurate measures of size, which would then be used to draw a sample of units that would be most beneficial to DAWN. In other words, two-phase sampling allows some opportunity to assess the likely yield of any given unit before enlisting it into the system, and the sample design benefits from information that is not otherwise available. This approach would be more costly in the short term but could also prove cost effective in the long term.

The redesign team researched the possibility of two-phase sampling using the current DAWN data. The feasibility of two-phase sampling depends on the following:

- Predictive ability of the 1st phase data
- Relative 1st and 2nd phase data collection costs

An attempt was made to measure the predictive ability of a few months of data vis-à-vis annual reported counts of events. The results were encouraging. Depending upon the estimate of interest, simple regression models yielded r-square measures of 0.80 to 0.98 (see Table 3-14), indicating that a large amount of variance in the annual measure was explained by the few months of data.

The regression model used was as follows:

$$\hat{Y}_{ijk} = B_{0jl} + B_{1jl} X_{ijl}$$

Where

$\hat{Y}_{ijk}$ = The total annual estimated count of episodes for unit *i*, estimate *j*, 12 month period *k*,

B_{0jl} = The intercept term for estimate *j*, 2 month period *l*,

B_{1jl} = The coefficient term for estimate *j*, 2 month period *l*,

X_{ijl} = The reported count of episodes for unit *i*, estimate *j*, 2 month period *l*.

Table 3-14. Minimum, Mean and Maximum R-square Measure for Two-Phase Models

Estimate	Min.	Mean	Max.
ED Visits	0.9684	0.9792	0.9862
Total episodes	0.9601	0.9696	0.9768
Cocaine episodes	0.9622	0.9710	0.9860
Heroin episodes	0.9337	0.9459	0.9679
Marijuana episodes	0.9263	0.9544	0.9817
Methamphetamine episodes	0.7258	0.8343	0.9341

The relative 1st and 2nd phase data collection costs will determine if the 1st phase's predictive ability can be utilized in a cost-effective way. This will depend on the cost structure of the new implementation and should be evaluated at that time.

Sampling ED Visits within Hospitals

The current DAWN sample design uses a stratified, single-stage cluster sample of hospitals and reviews all ED visits for DAWN-reportable episodes within selected hospitals. It was recommended that a two-stage design be evaluated in a cost vs. variance framework as an alternative to the single-stage design. Two-stage designs would involve the sampling of records within selected EDs (e.g., sampling records each day or taking all records from within selected days).

A proper two-stage sampling evaluation would be very similar to the two-phase evaluation described above and would yield similar results. It is expected that the prospects for the feasibility of two-stage sampling would be good for the more common estimates of interest. However, it would be expected that the prospects for sampling the increasingly rare estimates of interest would not be good at all. Since DAWN provides estimates for a large number of substances, (including not only those that have specific precision constraints for the sample redesign but also those

considerably less frequent), the redesign team recommend against two-stage sampling, as it would be to the detriment of identifying new and emerging drugs of abuse.

Merger/Demerger Protocol

A clear data collection protocol and data adjustment method that acknowledge the possibility of mergers and demergers and are informed from a sampling and estimation point of view are conspicuously absent from DAWN. Although too late to implement under the current design, such a protocol and adjustment method should be incorporated in the new sample design and in the new data collection protocol.

ADJUSTMENTS FOR MISSING DATA (IMPUTATION)

DAWN benefits from two relatively rare characteristics of sample surveys. First, DAWN consists of a panel sample of hospitals with 100 percent overlap between time periods (with the exception of sample maintenance selections). Second, monthly ED visits and (to a lesser extent) drug-related episodes are relatively stable across a short time period. These two characteristics present opportunities for developing procedures for adjustment of unit and item missing data. The use of past data for a facility, be it available data for the year under processing or data corresponding to the missing months in earlier years, should be explored.

Nonresponse Adjustment

The current nonresponse adjustment procedure uses characteristics at the time of sampling to form adjustment cells and does not take the size (e.g., ED visits) of nonresponding units into account. Changing both of these aspects could improve the bias correction capability of the nonresponse adjustments. The specific nature of these changes will depend, to some extent, on the variance estimation strategy and sample design actually implemented. Note that changes in unit characteristics between the time of sampling and estimation are customarily taken into account at the estimation stage, via nonresponse adjustment or post-stratification that considers the current characteristics.

Ratio Adjustment

The current estimation strategy uses a “benchmark” or ratio adjustment method to bring DAWN estimates of ED visits in line with known control totals derived from AHA data. This adjustment is done at the DAWN area level. A “no weights less than 1.0” rule is used, which tends to dampen the effect this adjustment has, but only when the DAWN estimate exceeds the AHA total. Weights can be less than 1.0 due to units selected with probabilities close to or equal to 1.0, in strata with little nonresponse adjustment, and in areas where the weighted DAWN estimate of ED visits after nonresponse adjustment is greater than the corresponding AHA control total. The redesign team recommended that SAMHSA lift this restriction, as that is consistent with the original decision to use the AHA data for ratio adjustment.

Variance Estimation

The current variance estimation scheme uses a Taylor series approximation appropriate for a stratified, single-stage cluster sample where the clusters are sampled with equal probability within stratum. This approach is appropriate for the proposed new design.

Sample Maintenance and Panel Rotation

The DAWN sample must allow units new to the population to have a chance of selection. This has been traditionally accomplished through the annual sample maintenance process. A panel rotation scheme could be used to keep the sample fresher in a more comprehensive way, allowing units that have become ineligible to be removed and replaced by eligible selections as well as allowing units new to the population to have a chance of selection. However, a panel rotation scheme would have periodic recruitment cost implications that should be considered.

Phasing In Strategies

SAMHSA requested that the redesign team develop options and make recommendations for "phasing in" the new sample. This request was motivated by the concern that SAMHSA would not be able to afford to field the new DAWN sample all at once, especially if the total sample sizes required were near those being projected for the most ambitious scenarios. The proposed new design (with facilities in 48 MSAs, 27 of which will be new to DAWN), can benefit from a phasing-in strategy. It is important that these options be considered up-front in the new data collection and analysis implementation, as these options have implications for other activities including overlap control and the panel rotation/sample maintenance scheme.

SAMHSA's objectives for "phasing in" a new DAWN sample were stated as follows:

- Control the start-up costs associated with fielding a new sample.
- Minimize the discontinuities created by "phasing in" the new sample.
- Reach analytic objectives as soon as possible.

Although not well documented in the statistical literature, the current practice of "phasing in" a new sample appears to be as follows:

- New samples are often phased in stratum-by-stratum.
- The "phase in" period is usually kept as short as possible.
- New samples are often run in parallel with old samples for a short period of time to measure discontinuities.

Because DAWN's primary stratification is at the MSA level, the practice of phasing by strata can be followed by definition. The second practice is driven by concerns about how quickly a design can become inefficient and is relevant here. Given the discontinuities that will be inherent in the implementation of the new DAWN design (new DAWN area definitions, new samples within

existing DAWN areas, new case definition, etc.), there is little apparent reason to consider the third practice given above.

There would appear to be two general options for "phasing in" the new sample. The first option would phase in by sample size across all targeted MSAs. The second option would phase in by MSA. These options and their advantages and disadvantages are described in more detail below.

"Phasing In" by Sample Size. Recruitment of facilities could occur in all targeted MSAs and the national panel in year 1 of the new design, but at initially reduced sample sizes in order to control start-up costs. The sample size required for full precision would be obtained after a number of years with periodic increases in sample size. The advantage to this approach is that all targeted MSAs would be included from the start. However, the primary disadvantage is that full precision for each targeted MSA and the national panel would not be achieved until the final year of the phase-in period.

"Phasing In" by MSA. Alternately, DAWN could begin recruitment of the full complement of sampled units in only some of the targeted MSAs and the national panel in the first year of the new design. Each year, additional MSAs would be brought into the system, also at the level of participation needed to achieve the desired precision levels. The advantage to this approach is that reasonably precise estimates are available for each MSA in their initial year of participation in DAWN. The disadvantages include the need to delay data collection in some MSAs until later years; the creation of a fluid stratification scheme, which has variance implications for the national estimate; and, in the worst case, the creation of a permanent discontinuity at the MSA level if the full design is never realized (i.e., in the face of unexpected funding or other constraints).

Having considered these options, the redesign team recommended that SAMHSA seriously consider the advantages and disadvantages of each approach prior to implementing the new design, considering how these options and limitations fit with the agency's overall plans for DAWN. It was also recommended that SAMHSA consult with and require collaboration between the data collection and analytic components on this issue, as the objectives, constraints, and cost implications from one operation could conflict with the other. On balance, it is likely that an approach that phases in the new sample by MSA may be best suited to the objectives of DAWN.

SUMMARY: THE PROPOSED NEW DESIGN

The purpose of this research was to develop an efficient sample design given SAMHSA's analytic objectives for DAWN and the available resources as they are currently understood and anticipated, respectively. The proposed new design is a stratified, single-stage cluster sample designed to yield 950 responding units in 48 MSAs and a national panel. This sample size must still be inflated for nonresponse. The stratification is by MSA, ownership (public or private), and size (up to 4 size strata within each MSA and ownership category, as described above). Units will be selected with equal probability within stratum. The design is based on the following requirements:

- **Level –** The design will produce estimates at the national and MSA level.
- **Estimates –** The design requires specified precision levels for total episodes, cocaine, heroin, and marijuana mentions.

- **Precision –** The minimum RSEs are 15 percent for national estimates and 10 percent for MSA estimates.

- **Costs –** Using the current reimbursement formula, The new design has an expected annual direct reimbursement cost of $3.36 million, compared to the current direct reimbursement cost of $1.3 million in 21 MSAs.

The proposed new design satisfies the above requirements through the following features:

- Requires an estimated 950 responding sample units;

- Includes 48 targeted MSAs;

- Includes Alaska and Hawaii in the national estimate; and

- Utilizes stratification by MSA, ownership, and size (ED visits).

REFERENCES

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Substance Abuse and Mental Health Services Administration, Office of Applied Studies. *Drug Abuse Warning Network: Sample Design and Estimation Procedures (Technical Report).* DAWN Series M-2, DHHS Publication No. (SMA) 98-3178, Rockville, MD, 1998.

4. REDESIGNING DAWN'S CASE DEFINITION, DATA ELEMENTS, AND CASE SCREENING PROCEDURES

Given the Substance Abuse and Mental Health Services Administration's (SAMHSA's) legislatively mandated data collection requirements, the analytic interests of the Drug Abuse Warning Network's (DAWN's) users, and the operational constraints inherent in collecting data in emergency departments (EDs), it was essential to assess whether DAWN was "asking the right questions" and collecting the most useful and appropriate data. The redesign team was asked to conduct a series of limited field studies that would allow the Office of Applied Studies (OAS) staff to understand and quantify the types of cases currently treated in EDs, the portion of those cases captured by DAWN, the consistency with which different types of cases were likely reported to DAWN, and the overall utility of the current case identification procedures. Based on the findings of these studies, recommendations were made for changes to the DAWN case definition (the rules used to determine a case's reportability to DAWN), the variables collected to describe each case, and the methods used to identify potentially reportable cases from among all ED patients.

This chapter reviews the limitations of the current case definition, the efforts to develop and test a proposed new case definition, proposed changes to the data elements (variables) collected about DAWN cases, and the likely impact on DAWN of implementing the proposed definition. In addition, this chapter reviews various methods currently used to identify DAWN cases in participating EDs, proposed changes that would standardize case identification methods, and the likely impact of implementing such changes.

THE CURRENT CASE DEFINITION

Since DAWN's inception, reporters in each participating facility have been asked to review the charts of patients treated in the ED to identify cases in which the presenting problem was induced by, or related to, substance abuse. For numerous logistical reasons, DAWN must continue to rely on retrospective chart review to obtain data. Conducting interviews with patients awaiting emergency treatment is logistically infeasible and raises numerous confidentiality concerns; asking physicians to collect data during the treatment encounter is likewise operationally difficult. Finally, without consistent standards for coding the contents of medical records, electronic intercept of DAWN data through fully computerized approaches is also infeasible at the present time. As a result of these constraining factors, the redesign team focused on developing better methods for more reliably identifying DAWN-reportable cases using reporters to review medical records in the participating EDs.

Reporters select from among all ED visits only those in which they determine that the ED patient *intended to abuse* the substance(s) involved, and the abuse of the drug is *related to* the presenting problem. These inclusion criteria are problematic for several reasons:

- "Intent to abuse" is difficult to determine because intent is rarely documented in the record except for suicide attempts. Emergency care personnel are concerned with treating the acute medical conditions of patients coming to the ED; identifying and

documenting the various factors contributing to the presenting condition are less important in the ED itself. Therefore, complete and accurate documentation of drug abuse is unlikely when patients present for conditions other than overdose or intoxication.

- For reasons related to possible denial of insurance reimbursement, physicians may be reluctant to document a relationship between drug use and the presenting problem.

- Protocols for the use of toxicology tests vary widely across EDs. In some EDs, toxicology tests are ordered for every patient, or for any of a number of specific presenting conditions. Other EDs order tests only as needed. In some EDs, test results are received while the patient is still in the ED; in other EDs, results are returned days later. In addition, except for a few specific substances (e.g., cocaine), a positive toxicology test does not necessarily indicate drug abuse, nor does it specify the relationship of the substance to the presenting complaint. DAWN reporters have inconsistent access to toxicology results and appear to make inconsistent use of them in determining the reportability of DAWN cases.

- Frequently, reporters can identify a case as intentional but cannot classify it with certainty into one of the categories currently used (i.e., it is difficult for a nonspecialist, working only from an ED chart, to differentiate "recreational use" from "dependence").

Given the reliance on ED chart documentation, the variability in documentation (including toxicology screens) across facilities, and the complexities of the current case definition, reporters must often make inferences from limited information to determine reportability to DAWN. When hundreds of individual reporters are asked to operationalize a case definition that relies on inconsistent documentation, inconsistency in applying the case definition is virtually assured. In short, the "intent" and "relatedness" criteria make case identification unreliable and case classification difficult. A new case definition is needed that will reduce reliance on reporters' judgement, improve the consistency in the cases reported to DAWN, and facilitate interpretation of the resulting data.

In response to this need, the redesign team considered three alternative case definitions: the current case definition (intentional abuse of a reportable substance), a narrow "toxic effects" definition, and a more inclusive "broad net" definition. The "toxic effects" and "broad net" definitions were proposed as alternatives for addressing variability in documentation practices across hospitals that make it difficult for reporters to identify cases reliably.

The "toxic effects" definition proposed to focus only on acute drug-related morbidity, in which the reason for the ED visit was explicitly attributed to the toxic effects of drug use, misuse, or abuse as documented in the patient's chart. By contrast, the "broad net" case definition was one in which nearly all cases with drug involvement would be reportable. This option was inspired by the Consumer Product Safety Commission's approach to the National Electronic Injury Surveillance System – an approach in which reporters are told to report all cases in which a consumer product is mentioned and analysts at a central data processing office then review and further code the cases as needed. For DAWN, it was hoped that a case definition could be developed that would minimize reporter judgment while allowing (but not requiring) analyst review of cases after the fact. During late summer and early fall of 2000, data were collected from several hospitals to test the viability of these case definition options and to assess their advantages and disadvantages relative to the current approach.

User Needs

In addition to assessing the feasibility of implementing an alternative case definition, the redesign team also considered the degree to which resulting data would serve the needs of DAWN's key audiences. As described in Chapter 1 of this report, the redesign process began with a detailed constituent analysis to assess current interest in DAWN. The redesign team identified a diverse set of audiences for DAWN, with a variety of needs and interests in data on drug-related morbidity. DAWN's constituents desire data at both national and community (metropolitan area or smaller) levels, and they desire estimates for different types of patient populations and conditions, including but not limited to the following:

- Licit and illicit drugs;
- Drug abuse, adverse reactions, medication misuse, accidental poisonings, malicious poisonings, and suicide attempts; and
- Patients seeking care for withdrawal, accidents/injuries, chronic effects of drug use, and other medical complications related to drug use.

DAWN's constituents require data with which to do the following:

- Track trends in drug problems across communities, nationally, and over time;
- Identify emerging drugs and new drug combinations;
- Learn the specific health consequences associated with different drugs;
- Make decisions about drug scheduling, drug labeling, and potential for abuse and diversion; and
- Learn the characteristics of patients seeking medical attention for different drug-related conditions.

Attention to meeting the needs of key users of the DAWN data was central to the redesign process. While it was true that DAWN cannot be all things to all people, the project proceeded on the belief that many audiences would use DAWN – and would find it more useful – if the case definition were adequately redesigned to address some or all of the above concerns. The next section reviews the proposed changes to the DAWN case definition that are intended to better serve these needs. That section is followed by a more detailed discussion of a field study through which the proposed changes were developed.

PROPOSED REVISION TO THE CASE DEFINITION

The findings of the project's field test indicated the following:

- The critical problem with the current case definition is the need to determine – retrospectively – a patient's intention when using a drug. ED charts rarely document intent. Even if one assumes that any illicit drug use is with intent to abuse, additional rules are required to determine whether the drug use was sufficiently "related to" the

presenting complaint to warrant reporting to DAWN. Rules for prescription and over-the-counter drugs were more difficult to develop, even for a small field test with only a few coders.

- Although the "toxic effects" definition had theoretical appeal, it did not identify a clinically distinct subset of cases. That is, relying on explicit documentation of drug toxicity as a contributing factor in the patient's condition required coders to exclude cases that were arguably drug-related. There were many cases without explicit attribution to drug abuse that were, in all other respects, identical to cases in which the chart noted that the presenting complaint was "secondary to" drug abuse. Emergency care staff on the redesign team's expert advisory panel were unable to agree on what constituted sufficient documentation. Further, it appeared that reporters with more medical training might be more likely to "know" that a case was drug-related compared to reporters with less medical training. This definition did not appear to identify a consistent and meaningful subset of drug-related ED cases in a manner that could be consistently applied by reporters of varying training, using charts developed by staff with varying documentation styles, across DAWN's many participating facilities.

- The "broad net" definition captured nearly all of the cases included in the current case definition, all of the cases included in the "toxic effects" definition, and a number of additional drug-related cases. Although a few exclusion rules were needed to set the boundary of the definition, these rules were relatively easy to develop and implement consistently. Because the "broad net" definition captures a wide variety of cases, new data elements (variables) are needed to sort and describe the cases reported.

Given the needs of DAWN's diverse constituency, the background of current and likely DAWN reporters, information available in ED charts, and the desire to develop simple reporting rules that include a clinically distinct set of cases, it was recommended that DAWN's new case definition "cast a broad net." This broad net should include (with a few specific exceptions) every case in which drugs, alcohol, or non-pharmaceuticals are part of the problem being addressed. In other words, sections of the medical record describing the *presenting problem, assessment and/or diagnosis* would refer to drug ingestion. New data elements would supply the means to subset the "catch" into categories of particular interest to different audiences.

Rule: Under this proposed case definition, a case would be reportable to DAWN if the presenting complaint, clinical assessment,[1] or diagnosis indicates that the patient has used drugs, alcohol, or other substances. Excluded from consideration are drugs recorded in a list of current medications, since this list includes substances that are not necessarily problematic for the clinical management of the patient. Notably, the proposed case definition eliminates both "intent to abuse" and "relatedness" as criteria for reportability. If the presenting complaint, assessment, or diagnosis sections of an ED chart have documentation of the use of a substance – whether or not the patient intended to abuse it – then the case would be reportable to DAWN. This change opens the door for inclusion of adverse drug reactions, malicious poisonings, and accidental poisonings that are not currently collected in DAWN.

[1] Included in the assessment would be any positive toxicology screen indicating the presence of a drug, subject to the exceptions noted.

Exceptions: There are a few exceptions to this general rule. Under the proposed case definition, an ED visit is *not* reportable to DAWN if the following occurs:

- There is no evidence of current drug use (e.g., Drug use is documented *only* as "history of" or is documented in the social history only);
- Alcohol is the sole substance documented and the age of the patient is 21 or older (i.e., Underage drinking *will be* reportable);
- A non-pharmaceutical is the sole substance and it has not been inhaled; or
- The visit is related to adjustment of a patient's medication levels.

These exceptions were developed for the following reasons. First, DAWN is designed to track trends in current drug abuse, not in the long-term effects of drug use (which could be moderated by any number of unrelated factors). For example, differences in documentation styles would impact the identification of chronic illnesses caused by past drug use. Since ED physicians are concerned with treating the presenting problem, they do not always document the underlying cause of the illness, particularly if the cause carries with it social stigma. Perhaps the best example of this is HIV/AIDS, which has many root causes, of which IV drug use is only one. Poor documentation of drug involvement in these cases, coupled with inter-reporter differences in making assumptions about drug involvement, lead to the recommendation to exclude such cases unless current drug use is noted in the record. The tracking of chronic illnesses and their etiology is better accomplished by the Centers for Disease Control and Prevention's (CDC's) surveillance efforts and should not be duplicated in DAWN.

Second, this case definition recommendation attempts to address some of the requests of DAWN's audiences for data on cases involving only alcohol. As reported later in this chapter, analyses of data from a field study and from the National Electronic Injury Surveillance System (NEISS) suggest that adding "alcohol only" cases to DAWN would overwhelm the system, as much as tripling the number of cases reported. Additionally, findings from the study of the impacts of health system change (see Chapter 2) show that a large number of "alcohol only" patients are seen in the ED as a result of local policies to manage the problem of public intoxication. Variation in these policies across cities and over time are likely to have a notable influence on observed trends. Thus, trends in adult alcohol cases in DAWN are more likely to reflect changes in local policies than in underlying levels of morbidity.

However, DAWN is the only major substance abuse data collection effort that does not include alcohol among the list of drugs surveyed. There is a definite need to monitor the effects of alcohol abuse, particularly among youth (under age 21), for whom alcohol is an illegal substance. Visits to the ED by underage drinkers are more reflective of morbidity than are visits by older drinkers, many of whom are "chronic inebriates" seeking temporary shelter. The data also suggest that the volume of underage drinking cases will be manageable in terms of reporter burden. Therefore, as a compromise between user needs and resource constraints, it was recommended that underage drinking be added to the set of cases collected by DAWN, but that "alcohol only" episodes for patients of legal drinking age should continue to be excluded.

Third, analysis of data from NEISS suggests that expanding the case definition to include "any use of a substance" potentially introduces a large volume of cases involving exposure to household products and hazardous materials. For the most part, collection of data on the health consequences associated with non-pharmaceuticals is successfully accomplished by NEISS,

and that effort should not be duplicated in DAWN. However, substances of abuse emerge unexpectedly, and chemicals and household products are sometimes abused, typically by inhalation. Therefore, it was recommended that the use of non-pharmaceuticals be reportable to DAWN if they were inhaled. Non-inhaled, non-pharmaceuticals (e.g., burns caused by spilled chemicals or cleaning supplies ingested by toddlers) would not be included in the proposed case definition.

Finally, in the process of reviewing data in the field test, it was determined that a rule must be developed to exclude ED visits related to medication adjustment. DAWN is designed to monitor adverse health consequences associated with drugs. Because of metabolic differences among patients, some may experience adverse health consequences during a period in which their physicians are attempting to stabilize them on a new medication. Sometimes these symptoms result in ED visits. Because these reactions are, in effect, part of the normal course of the therapeutic process, they fall outside the intended scope of DAWN. The most prevalent example of this kind of case involves hypoglycemic episodes due to insulin reactions in diabetics. Because the field test was implemented in only a few hospitals and only a handful of these cases were encountered, better specification of this exclusion rule may not be possible until the new definition is actually implemented.

Proposed Changes to the Data Processing Approach

Recommendations from the field test included two important changes to the way DAWN data are processed. First, collection of a brief "case description" for all reported cases was proposed. This would be an open-text field in which the reporter would be asked to record the presenting problem and assessment(s) as noted in the ED chart. Such information is not currently available in DAWN, and central data processing staff has no indication from the current report forms whether a submitted case actually met the reportability criteria. The proposed case description field would permit data processing staff to double-check the reportability of cases, to identify common circumstances in which reporter errors occur, and to identify circumstances associated with emerging drug problems.

A second proposed change is to begin thinking about cases in terms of several distinct types. Since its inception, DAWN has reported all cases in the aggregate as "drug abuse" cases, which was appropriate given the case definition in use. With the proposed broad net case definition, DAWN will continue to collect primarily drug abuse cases, but it will also include cases such as adverse drug reactions in which no abuse was intended. For proper analysis and interpretation, DAWN's varied audiences will require cases to be disaggregated into the key types included in the proposed case definition. Thus, it was recommend that reporters classify reportable cases into types using the flow chart below.

Based on the field study data and the interests of DAWN's users, there appear to be eight different "types" of reportable cases:

- Suicide attempts – defined strictly as documentation of "suicide attempt" or "attempted to kill self" by means of a drug overdose. Suicidal gestures, suicidal ideation, or ingestion of multiple pills are not sufficient to be included in this category.

- Seeking detox – a category made necessary by hospital administrative policies that may require patients to obtain medical clearance in the ED for substance abuse treatment. These cases are characterized by documentation that the patient is seeking

"detox," "rehab," "medical clearance" or "help for a drug problem." This category, coupled with the "disposition from ED" variable, will allow OAS to track the effects of ED administrative policies on DAWN estimates over time.

- Underage drinking – defined as documentation of alcohol use in the absence of any other substances in patients under 21 years of age.

- Adverse drug reaction – defined as any case with documentation of a reaction to a prescription or over-the-counter drug and no evidence that the drug was used counter to direction. These cases include allergic reactions to drugs, drug/drug interactions, and instructions to discontinue use of a prescription or over-the-counter drug.

- Overmedication – to include cases with documentation that patients took more of a prescribed or over-the-counter drug than instructed, either because they forgot they had already taken a dose, they were trying to make up for a missed dose, or because symptoms did not subside with the recommended dose.

- Malicious poisoning – to include cases in which a patient is poisoned by someone else; this category includes the "drug rape" cases many users assume to be included in DAWN.

- Accidental poisoning – to include cases in which children ingest pills or other substances by mistake, or when individuals ingest a drug not realizing its nature.

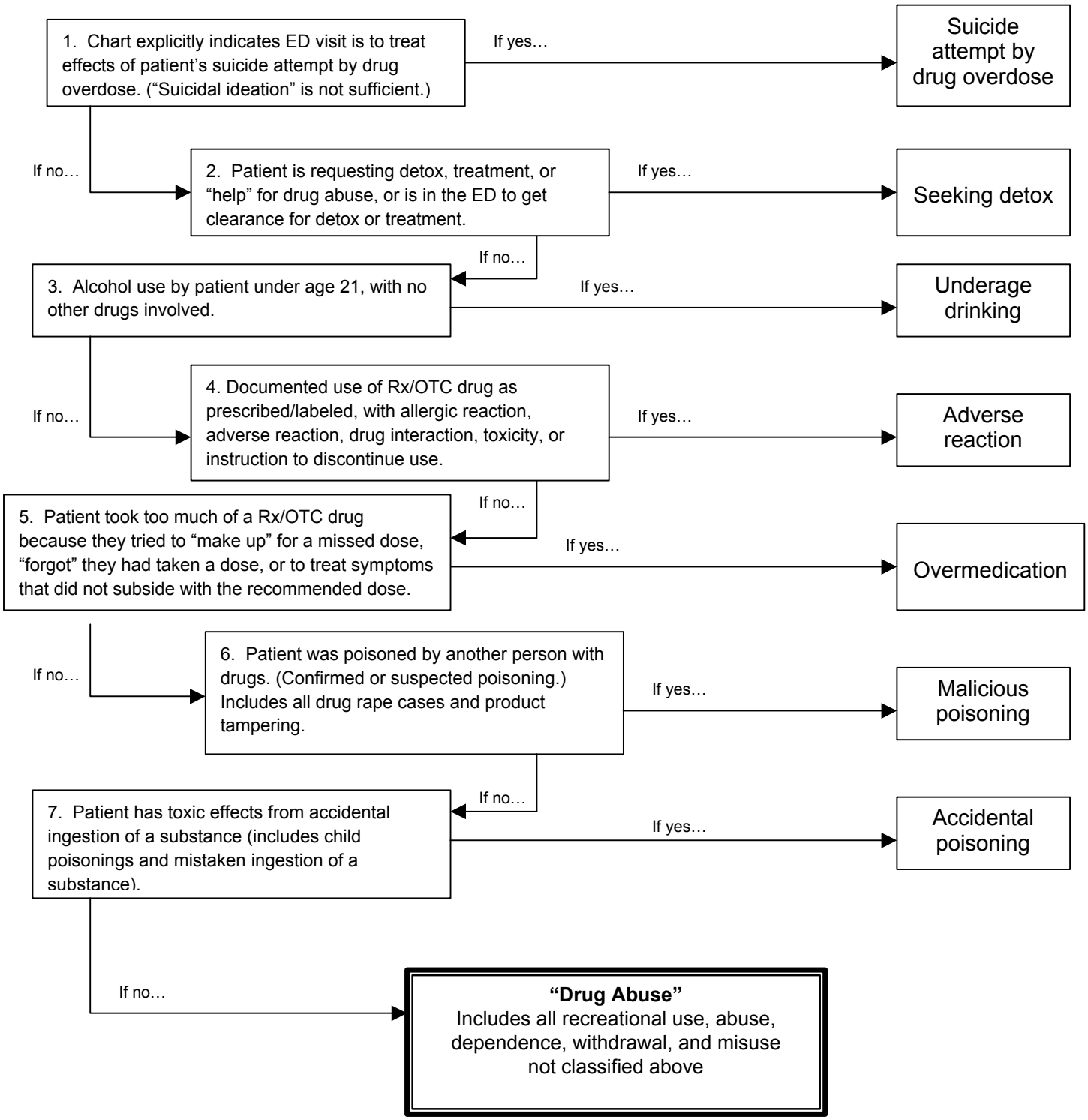
- All other drug abuse – intended as a "catch all" category to include all other cases not classified above. These cases can be further categorized using the data elements (variables) proposed for collection.

The "type of case" classification (see Figure 4-1) is important for subsetting different categories of cases that will be reported under the new DAWN. These can be defined to be mutually exclusive but prioritized categories, and the decision boxes in the following chart provide short-hand criteria for each. It was recommended that each of the first seven categories be defined very narrowly; it is expected that there would be relatively few cases in any one of these categories. All other cases (particularly the large number for which determining intent is impossible) would filter down into a general drug abuse category.

DESCRIBING CASES IN THE "BROAD NET"

Currently, DAWN collects a limited number of data elements (variables) with which to describe cases. Among the limitations of the current approach, DAWN collects no information on the medical conditions for which drug users seek treatment in EDs. Given the proposed expansion of the case definition to include a broader array of cases, it will be important to include data elements that will allow DAWN's users to subset different groups of cases that may be of particular analytic interest (e.g., to separate adverse reactions to prescription drugs from illicit drug overdoses). To accomplish these objectives, the redesign team recommended a series of changes to the data elements collected on DAWN cases.

Figure 4-1. Type of Case Classification. What type of case is it? Classify the case as the first type for which it meets the specified criteria. Make your decision based on documentation in the chart. Do not assume or infer.



The proposed data elements fall into four general categories:

- Operations Data – these elements include items necessary for processing DAWN cases, including the provider number, reporters' cross-reference numbers, and date/time of ED visit.

- Demographic Data – these include basic patient information such as age, sex, race/ethnicity, and living arrangements.

- Drug Data – several fields will be available to record the drugs implicated in the ED visit. Reporters will be asked to record only those substances with documented relevance to the ED visit, not all of the substances "on board" or for which a patient has a current prescription.

- Case Description Data – these data elements represent the most significant change to the DAWN data collection process, as they will provide substantial detail on the medical conditions for which patients seek treatment, the type of case, and disposition from the ED.

Table 4-1 describes each of the proposed changes to the DAWN data elements, including items to be added, changed, deleted, or retained from the DAWN data collection form. A brief description of the reason for the proposed changes is provided for each element.

APPLICATION OF THE PROPOSED CASE DEFINITION AND DATA ELEMENTS

This section details findings obtained in the redesign team's field test of the proposed case definition and data elements. The field study was structured to assess the feasibility of different case definition options, to develop and clarify coding decisions, and to estimate the likely change in the volume of cases with the adoption of the new, proposed case definition.

Procedure

In order to test the feasibility of the broad net case definition and data elements, members of the redesign team visited five hospital EDs currently reporting data to DAWN. Three of the DAWN hospitals were in inner city settings and were known to treat a high number of substance abuse cases. One suburban hospital was expected to provide access to fewer substance abuse cases but more alcohol and adverse drug reactions. The other suburban hospital was known to treat a high number of substance abuse cases due to the fact that psychiatric cases from the surrounding area were sent preferentially to its psychiatric emergency room. As part of a special study on case identification methods (reported later in this chapter), researchers at a large university hospital were asked to collect information about substance-related visits treated in their ED. "University Hospital" is an inner city hospital known to treat a large number of cases involving substance abuse. Thus, these six hospitals were a convenience sample, selected to maximize the number of cases involving different kinds of substance abuse.

Table 4-1. Recommended Data Elements for DAWN (ED Component)

Data Element	Recommended change	Explanation
Provider number		A unique hospital identifier, for SAMHSA use only.
Cross-reference		A record identifier for reporter use only.
Date and Time of ED Visit	Month of visit	For SAMHSA use only. Date/time of visit, when combined with other case characteristics, could potentially identify an individual. Month of visit is the smallest unit needed to process and report DAWN data.
Age	Remove age limits	DAWN should collect data for patients of all ages. To protect individual identities, age categories should be collapsed for all patients under age 6 and over age 85 when reported.
Sex	None	To be retained.
Ethnicity/Race	White/Black/Hispanic/Other	Reporters have substantial difficulty with the ethnicity category (not understanding it, or the information is not available). Recommend reverting to the 4-category combined race/ethnicity variable.
Patient's Home Zip Code	Living arrangements (fixed address, no fixed address, not documented)	Zip code data are often unavailable, or require reporters to access separate databases. The data are not available for public use, and can potentially be used to identify individual patients. Because policies toward the homeless can have a substantial effect on ED case volume, the recommendation is to change this variable to focus on whether or not patients are homeless.
Case description	Open-text field in which reporters record information about the presenting complaint and assessment.	This is a new data element. For SAMHSA use only.
Reason for Taking Substances	Do not collect.	Eliminate from current form. Replace with "Type of case" (see below).
Type of Case	Eight categories, described in flow chart above.	This is a new data element.
Reason for Present Contact	Do not collect.	Eliminate from current form. Replace with "Presenting complaint" (see below).
Presenting Complaint or Condition	Categories to identify the type of medical condition for which the patient sought treatment in the ED. To be developed.	This is a new data element. Findings from the field study suggest an initial list of conditions, but the data collection contractor should monitor information in the "case description" variable over the first several months of data collection to develop and refine a comprehensive and analytically useful list.
Diagnosis(es)	Text field; record all listed diagnoses.	This is a new data element. Diagnoses could be categorized as needed to meet specific research questions.
Alcohol involved?	None	To be retained.

Table 4-1. Recommended Data Elements for DAWN (ED Component) (continued)

Data Element	Recommended change	Explanation
Drug(s) involved – list all substances separately	Allow reporters to list up to 6 substances plus alcohol (currently 4 + alcohol)	Addition of Rx/OTC reactions may necessitate these additional fields.
Form in which drug was acquired	Do not collect.	
Route of administration	Change to include only four categories: injected, oral, inhaled/sniffed/snorted/smoked, and information not documented.	For SAMHSA use only. This data element will be used only to facilitate correct classification of nonpharmaceuticals (i.e., inhalants), as well as to differentiate prescription and over-the-counter medicines available in different forms (e.g., antihistamine pills versus nasal sprays).
Source of substance	Do not collect.	
Disposition	Revise to include more specific categories: (a) Treated and released (discharged home, transferred, sent to drug treatment/detox, released to police custody); (b) Admitted (ICU/critical care, medical/surgery, psychiatric unit, chemical dependency/detox unit); (c) Left against medical advice; (d) Died; and (e) Information not documented	In recent years, about 48% of DAWN cases were "treated and released," while another 48% were "admitted." More information is needed to differentiate patients in these categories. In particular, more information is needed to indicate when the ED is a route of entry into the substance abuse treatment system.
Coded remarks	Do not collect.	
Urgency / Acuity	Do not collect.	The field test indicates that because of substantial variation in ED triage and documentation procedures, these data cannot be collected using a standard set of categories.
Insurance coverage	Do not collect.	The field test indicates that this information is not readily available to DAWN reporters.
Source of information	Do not collect.	The field test indicates that because of substantial variation in ED treatment and documentation practices, it would be operationally difficult and analytically meaningless to ask reporters to document what sections of the chart contained information about the circumstances of the case. The "case description" variable should provide sufficient detail for analytic and quality control purposes.

Research staff visiting each of the hospitals reviewed the entire ED chart for each patient treated in the ED during a specified period of time. The period of time varied among hospitals due to differences in patient volume; charts were reviewed for as many days as feasible during a 2- or 3-day site visit. Because the field test also needed to assess the appropriate boundaries for the "broad net" definition, data were collected for every case with *any* mention of a substance in the ED chart, including consumer products such as bleach. By being overly inclusive at this stage, the field test allowed the research team to test different definitions and decision rules on the same set of data. In order to better understand what kinds of cases were being treated in the ED, several data elements were collected for each substance-related case, including a verbatim case description based on the presenting complaint, history of presenting illness, clinician assessment, diagnosis, and disposition.

The research team then coded the case description fields for a variety of characteristics that were gradually refined to become the proposed case definition and data elements. Coders were trained on the rules for the current case definition, the proposed case description, and the proposed data elements. Each case was double-coded by two coders working independently, and differences were reconciled by discussion among the research team and with OAS. These discussions helped to clarify issues associated with coding and further refined coding rules for the data elements. Throughout the field study, a decision on including alcohol-only cases was under consideration. As a result, data for both adult and underage drinking are included in the data shown here.

Results

Of 8,157 records reviewed at the six hospitals, 277 met the current case definition criteria, and 333 met criteria for the proposed broad net case definition. A total of 248 cases involved documentation of current alcohol use but no other current drug use. There is some overlap between the "Alcohol Only" cases and the other DAWN cases: three alcohol-only cases met criteria for the current case definition because they involved documentation of past drug use. Only 20 alcohol-only cases involved underage drinking; in the following tables, these 20 cases are included in both the alcohol-only columns and the proposed case definition columns.

Table 4-2 displays the 10 most common diagnoses detected under the current case definition, the proposed case definition, and in cases involving the use of alcohol alone. As shown, the major difference in diagnosis between the current case definition and the proposed case definition is the adverse drug reactions included in the proposed new definition. Notably, among alcohol only cases, a very high proportion (60%) carry a diagnosis of intoxication, whereas very few cases in the current and proposed case definition carry this diagnosis.

Table 4-3 displays several categories of cases and shows whether they are included in the current and proposed case definitions. The purpose of this table is to illustrate some of the information used in establishing rules for reportability, as well as in developing rules for the proposed "type of case" data element. Of note, the proposed case definition adds adverse drug reactions, overmedication, malicious poisoning, and accidental poisoning. With very few exceptions, all cases in these categories are new to DAWN under the broad net definition.

Table 4-2. Ten Most Common Diagnoses in Drug-Related Cases (Not mutually exclusive)

	Current Case Definition		Proposed Case Definition		Alcohol Only	
Diagnosis	N	% of Cases	N	% of Cases	N	% of Cases
Substance Abuse	75	27.1%	79	23.7%	37	14.9%
Intoxication	41	14.8%	50	15.0%	149	60.1%
Depression	36	13.0%	36	10.8%	5	2.0%
Suicidality	30	10.8%	30	9.0%	1	0.4%
Drug or Alcohol Dependence	23	8.3%	23	6.9%	6	2.4%
Withdrawal	22	7.9%	22	6.6%	11	4.4%
Overdose	16	5.8%	16	4.8%	0	0.0%
Cellulitis/Abscesses	16	5.8%	13	3.9%	0	0.0%
Toxicity	3	1.1%	7	2.1%	0	0.0%
Adverse Drug Reaction	1	< 1%	19	5.7%	1	0.4%

Table 4-3. Categories Included in Current and Proposed Case Definitions

Category	Number of Cases	Included in Current Case Definition?	Included in Proposed Case Definition?
Suicide Attempt by Drug Overdose	5	Yes	Yes
Seeking Detox	49	Yes	Yes
Allergic/Adverse Reaction to Drugs Taken For Medical Condition	45	2 of 45 (ADRs along with illicit drug use)	Yes
Overmedication	5	3 of 5 (took additional meds to enhance effects)	Yes
Alcohol/Drug Interaction	0	No	Yes
Alcohol Only			
Under 21 years old	20	3 of 228 with a history of substance abuse	Yes
Over 21 years old	228		No
Malicious Poisoning	2	1 in conjunction with illicit drug use	Yes
Accidental Ingestion	0	No	Yes
Inhaled Substances (other than drugs)	0		
If intent to abuse		Yes	Yes
Other		No	No
History of Drug Use	7	Yes	No
All Other Cases with Substance Use	207	Yes	Yes
TOTAL		277	333

Table 4-4 shows the breakdown of cases as categorized by the proposed “type of case” data element. As expected, there are relatively few cases in most of the first seven categories, as these are defined narrowly. The variable appears particularly useful for disaggregating three key categories of interest – underage drinking, adverse reactions, and patients who are seeking detox. For analytic purposes and in the interests of DAWN’s audiences, the ability to readily identify these cases is important. Although there are very small numbers of cases in the

remaining categories, it is recommended that they be maintained because some analysts may find them useful and because the field study data are not representative of all DAWN hospitals. The substantial proportion of cases filtering down into the "other drug abuse" category is not surprising given the type of information DAWN collects. Use of other proposed data elements can help analysts to further subset these cases (e.g., to identify psychiatric emergencies or inhalant abuse).

Table 4-4. "Type of Case" Results from Field Study

Category	Number of Cases	Percent of Total
Suicide Attempt by Drug Overdose	5	2%
Seeking Detox	49	15%
Underage Drinking	20	6%
Allergic/Adverse Drug Reaction	45	14%
Overmedication	5	2%
Malicious Poisoning	2	1%
Accidental Poisoning	0	0%
All Other Cases Involving Substance Use	208	62%
TOTAL	**333**	**100%**

Table 4-5 displays some common conditions associated with the proposed case definition. There is a high degree of overlap among these categories, and they are not mutually exclusive. Note that there are many cases involving psychiatric emergencies among the data involving drugs, and many intoxication cases among the "alcohol only" cases. These findings emphasize the importance of psychiatric consequences associated with drug use, and that alcohol-only cases are dominated by cases of intoxication, rather than by more serious medical conditions.

Monitoring the kinds of conditions treated is useful for interpreting trends in DAWN data, since some conditions are known to be treated in places other than EDs. The number of cases treated in the ED for less urgent conditions depends on a local health care system that is vulnerable to change. DAWN currently provides no information about the medical conditions associated with drug-related ED visits. A "presenting complaint" variable could therefore be very useful in helping to describe the ways in which drug abuse manifests itself in EDs over time. The list of conditions in Table 4-5 is a preliminary list based on a data from a few hospitals; a final list can be developed by monitoring the case description field for the first several months after the new case definition is implemented.

Table 4-5. Selected Conditions Associated with Cases

	Current Case Definition		Proposed Case Definition		Alcohol Only	
	N	%	N	%	N	%
Toxic Ingestion/ Overdose	32	12%	32	10%	0	0%
Seizures	8	3%	10	3%	9	4%
Chest Pain	20	7%	21	6%	5	2%
Psychiatric Emergencies	94	34%	98	29%	10	4%
Accidents/Injuries	38	14%	43	13%	38	15%
Intoxication	42	15%	40	12%	166	67%
Organ Damage	1	0%	0	0%	10	4%
Conditions Associated with Administration of Drugs (e.g., injecting)	27	10%	23	7%	0	0%
Withdrawal	31	11%	31	9%	10	4%
Premature Labor	3	1%	3	1%	1	0%
Seeking Detox	52	19%	52	16%	21	8%

Table 4-6 displays the disposition of cases captured under the current and proposed case definitions, as well as the cases involving alcohol only. Notably, fewer alcohol only cases are admitted to inpatient settings from the ED than cases identified under the current and proposed case definitions. A full 62 percent of alcohol-only cases were treated and released, indicating again that these cases are less medically urgent than cases captured under the current and proposed case definitions.

Table 4-6. Disposition of Cases

Disposition	Current Cases		Proposed cases		Alcohol Only	
	N	%	N	%	N	%
Treated and Released, no referral noted	89	32.4%	143	42.9%	156	62.9%
Treated and Released, referral noted:						
-Referred to Medical Clinic	1	0.4%	3	1.2%	5	2.0%
-Referred to Psych. ED	7	2.5%	7	2.1%	1	0.4%
-Referred to Drug/Alcohol Treatment	50	17.8%	49	14.6%	28	11.3%
-Referred to Urgent Care	5	1.8%	5	1.5%	3	1.2%
-Referred to Outpatient Psychiatry	2	0.7%	2	0.6%	1	0.4%
Released to Police Custody	2	0.7%	2	0.6%	0	0.0%
Admitted - ICU	6	2.1%	7	2.1%	4	1.6%
Admitted - Med/Surg	59	21.4%	62	18.5%	18	7.3%
Admitted – Psych. Inpatient	22	7.8%	22	6.9%	2	0.8%
Left Against Medical Advice	11	3.9%	11	3.3%	19	7.7%
Died	2	0.7%	2	0.6%	0	0.0%
Other	17	6.4%	14	4.2%	7	2.8%
Unknown	4	1.4%	4	1.2%	4	1.6%
TOTAL	277	100%	333	100%	248	100%

Finally, Table 4-7 displays information about several data elements that could not be consistently operationalized across the hospitals providing data for this field test and the source or implications of problems with these data elements.

Table 4-7. Problematic Data Elements

Data Element	Documentation	Problem
Ethnicity/Race	87% missing Ethnicity 40% missing Race	Ethnicity and race were sometimes mentioned in the clinical notes, but data were not consistently documented and it was unclear whether the same categories were consistently applied. Although race is arguably important for understanding drug abuse trends, it is unlikely that ethnicity data will be able to be collected with any degree of consistency across hospitals.
Zip code	49% missing	The research team often did not have access to billing data that contained this data element.
Homelessness	Unlike race and zip code, it is not possible to tell when homelessness is true but undocumented.	As expected, homelessness was not common, but was occasionally noted in the chart (for instance, it was noted that the patient was released to a shelter). Homelessness was sometimes documented in the clinical notes, even though there was an address associated with the record. Although a "homelessness" value may be a useful element under a general "living arrangements" variable, analysts should note that homelessness will be under-reported because this information is not reliably documented.
Primary Expected Source of Payment	85% missing, remainder impossible to code	This variable was not consistently documented in the records reviewed. Some of the data were maintained in billing databases to which the research team did not have access. In other hospitals, the medical records contained information about the expected source of payment. However, the data were difficult to interpret, for several reasons. When documented, charts often included the name of a specific health plan or HMO. Without knowledge of the patient's specific plan or plans available in the city, it was impossible to classify named plans correctly. A more generic list of categories (i.e., public pay vs. private pay) was attempted, but this was not useful because several commercial HMOs offer coverage under Medicaid and Medicare. Finally, in some charts multiple sources of payment were documented.
Acuity of Presenting Condition	32% missing, majority of remainder impossible to code	This variable was not consistently documented across the studied hospitals. When documented, different systems for describing acuity were used and they were not comparable.

Expected Burden of the Proposed Case Definition

Because the six hospitals used in the case definition field test are not representative of all DAWN hospitals, these data cannot be used alone to estimate the likely impact of the new case definition. Instead, data from the Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS) were used to provide an initial indication of the volume of cases likely to be generated under the proposed case criteria.

NEISS has recently begun collecting data about a wide range of cases treated in the EDs of U.S. hospitals. Once restricted to collection of information about consumer products, NEISS now

collects information on two classes of cases treated in the ED: (1) all nonfatal injuries and (2) medical conditions with a documented external cause. A nationally representative sample of 66 NEISS hospitals began reporting these data in July 2000. Included in NEISS cases are acute conditions related to the use of licit and illicit drugs, use of alcohol, and toxic reactions resulting from contact with household poisons or industrial chemicals. Although the NEISS case definition does not include all cases that would be reportable to DAWN, the overlap is sufficient to allow some meaningful analyses of NEISS data to inform the DAWN redesign. Importantly, NEISS is the only ongoing data collection system outside of DAWN that would allow for preliminary analyses of this type on a nationally-representative sample of ED cases.

CPSC provided raw data on 83,888 NEISS cases collected from July 1 to August 31, 2000. The data file included information about products involved in the presenting condition, as well as a diagnosis and an open text field describing the condition. Of these cases, 1,551 met the criteria for the proposed new DAWN case definition. NEISS contained some drug-related cases that were excluded for a number of reasons. Specifically, all cases in which screening for drug use (drug testing) was requested by an employer or parent, but seemed unrelated to a patient's health complaint, were excluded. Also excluded were a number of cases in which substances were not directly related to the presenting condition. For example, injuries caused by falling beer kegs were not included unless someone had actually ingested the beer. Also excluded were cases in which a patient choked on pills.

Table 4-8 displays the different categories that comprise the proposed new DAWN definition. In NEISS, the number of adverse drug reaction cases is nearly two-thirds that of the substance abuse cases. This ratio is considerably higher than the ratio found in the field study hospitals. NEISS is more sensitive to adverse reaction cases than to conditions related to substance abuse because NEISS captures only conditions with an external cause. DAWN cases that involve patients seeking detox or psychiatric emergencies, in which substances play a contributing rather than a causal role, may not be consistently identified by NEISS.

Table 4-8. Characteristics of NEISS Cases Meeting the Proposed Case Definition

	DAWN Cases
Overdose/Abuse of Drugs (or alcohol and drugs in combination)	656
Adverse Drug Reactions	422
Overmedication	50
Accidental poisoning (children)	181
Inhalation of nonpharmaceuticals	53
Underage drinking	181
Malicious poisoning	8
TOTAL	**1,551**

Another important consideration was the variation in the number of proposed DAWN cases by size of hospital. The field study focused on large, high volume DAWN hospitals, and therefore provided little insight into how the adoption of the proposed case definition might differentially impact hospitals of varying size. CSPC classifies its hospitals into four categories based on size. Thirty-one of the hospitals were classified as "small" hospitals, with annual visits under 15,730. Nine of the hospitals were "medium" hospitals, with annual visits between 15,731 and 25,895; six hospitals were "large" hospitals, with annual visits from 25,896 to 42,498.

Finally, there were 15 “very large” hospitals with annual ED visits greater than 42,498. Five hospitals specializing in care for children participate in NEISS as well.

Table 4-9 shows that the number of NEISS cases meeting the proposed DAWN definition varied widely, from 0 to 157 cases over the two-month period. Large hospitals provided more cases than smaller ones, but the standard deviation was quite large in the large hospitals.

Table 4-9. Number of New Cases by Size of Hospital

Hospital Type	# OF HOSPITALS	DAWN Cases identified	RANGE OF DAWN VISITS PER HOSPITAL	Mean (S.D.)
Children’s	5	175	0-79	35 (28.35)
Small	31	266	0-29	8.77 (7.68)
Medium	9	159	2-48	17.67 (15.22)
Large	6	272	2-157	44.33 (57.72)
Very Large	15	679	0-155	45.27 (38.53)
TOTAL	**66**	**1,551**	**0-155**	**23.5 (30.8)**

Besides looking at the total volume of reportable cases, it is also instructive to look at the ratio of new cases to current DAWN cases. Such data provide a better understanding of the total burden on reporters, who must review all available charts in order to identify cases. Thus, any given number of cases will not fully reflect the total burden involved in identifying those cases. Table 4-10 shows the number of ED visits in each hospital stratum, as well as the number of cases meeting the current and proposed DAWN case definitions. These data are estimated based on incomplete raw data provided by CPSC; notably, two hospitals did not provide information about the total number of ED visits in the previous year, so these hospitals are not included in this table. Also, the total number of visits for some of the hospitals has apparently increased since they were originally sampled, and they have not been reassigned to new strata to reflect this change.

Table 4-10 places the ratio of new cases to current cases at about two to one. That is, the analysis of NEISS data would suggest that the proposed new case definition will roughly double the number of cases reported to DAWN. Overall, one new case is detected for every 216 records reviewed, although there is considerable variability among hospitals. These figures are likely to be slight underestimates because NEISS is not likely to detect a portion of DAWN cases in which substances play a contributing rather than a causal role.

Analyses of data from six DAWN hospitals and from hospitals participating in NEISS, suggested that proposed the new case definition was readily operationalized. These data helped clarify boundaries (i.e., exclusion criteria) for the proposed definition, and provided guidance for development or exclusion of new data elements. The proposed new case definition improves upon aspects of the current case definition. It does not require coders to speculate about the intent involved in the ingestion of a substance or the medical relationship between the condition being treated and the ingested substance.

Table 4-10. Estimated ED Visits per Reportable Case (NEISS Data, July-August, 2000)

Stratum	# Sites	Estimated Number of ED Visits			Est. ED Visits in 2 months	Proposed Case Definition			Current Case Definition		
		Total	Average	SD		Number New Cases	ED Visit per Case	Cases per ED Visit	Number Current Cases	ED Visit per Case	Cases per ED Visit
Children's	5	250,910	50,182	15,595	41,818.33	175	2,393.0	0.004	44	950	0.001
Small	30*	270,958	9,031	6,237	45,159.67	266	169.8	0.006	78	579	0.002
Medium	8*	228,186	28,523	13,360	38,031.00	159	239.2	0.004	64	594	0.002
Large	6	393,590	65,598	29,195	65,598.33	272	241.2	0.004	151	434	0.002
Very Large	15	866,425	57,761	20,488	144,404.17	679	212.7	0.005	319	453	0.002
TOTAL	64	2,010,069	31,407	27,536	335,011.50	1551	216.0	0.005	656	511	0.002

* Missing data from one hospital

While the proposed case definition is likely to substantially increase the number of cases reported to DAWN, it also substantially increases the potential applications for those data. The recommended data elements will provide more information on the medical conditions for which individuals seek emergency care, and will allow analysts some flexibility in subsetting cases of interest (e.g., adverse reactions, underage drinking, and child poisonings).

The proposed new case definition may have implications for how reporters identify cases. In order to identify cases effectively and to minimize reporter burden, some hospitals may need to employ different screening strategies. The following section describes the two most common screening methods currently in use (ED log review and ICD-9-CM screens), and how case identification is likely to be affected by use of these methods in conjunction with the proposed definition.

CASE IDENTIFICATION PROCEDURES

There are three methods now in place for identifying DAWN cases. The standard, preferred method is for reporters to review all patient medical records for all ED visits, and then file DAWN reports for those meeting the case criteria. (This is often called the “100 percent medical record review” method.) The other two approaches involve the screening of medical records to identify likely DAWN cases, and then reviewing the full medical record for only those cases flagged by the screening method. One method relies on the ED log, which lists patient name, identifying characteristics, presenting complaint, and disposition for every visit. Information is entered into the log at the initiation of the ED visit. In the “log screen” method, the DAWN reporter examines the ED log for cases likely to be related to drugs, then reviews the medical records for only those cases. Another method relies on ICD-9-CM codes to screen for potential drug-related cases. In that method, the reporter reviews billing records to identify ED visits that were assigned any of a number of pre-specified ICD-9-CM codes. Only those medical records associated with specific ICD-9-CM criteria are reviewed.

Screening methods are typically used in DAWN hospitals that do not to have full access to all ED patient medical records, or in hospitals that have a very low ratio of DAWN cases to ED visits. For reporters in the latter type of EDs, a screening method helps reduce the substantial burden of reviewing large numbers of ED medical records to identify very few cases. While screening methods save considerable effort in that fewer medical records need to be reviewed, these methods also increase the risk of missing DAWN cases. The performance of these screening methods has never been systematically assessed under the current case definition; it is not known how well either screening method will perform under the rules of the proposed "broad net" definition. The redesign team was asked to conduct a preliminary assessment of each screening method under the current versus proposed case definitions, and to make a recommendation on optimal case identification procedures.

Three key concepts involved in the evaluation of DAWN's screening systems are the concepts of sensitivity, specificity, and positive predictive value. *Sensitivity* is the probability that if a record is a DAWN case it will actually be flagged by the screening process. It is the ratio of DAWN cases that screen positive ("true positives") to all DAWN cases. If the sensitivity of the screen is low, many DAWN cases are falsely ruled out by the screening process, and one can say that there are a high number of "false negatives." The *specificity* of a screen is the ratio of non-DAWN cases correctly ruled out to all non-DAWN cases. When specificity is low, there are many non-cases that are positively flagged by the screen. In other words, there are a high number of "false positives."

While sensitivity and specificity of a screen are measures of accuracy, the actual usefulness of a screen can depend on the prevalence of the issue being detected. An additional parameter, the *positive predictive value,* is needed to evaluate a screening system. The positive predictive value is the probability that a record flagged by the screen will, after medical record review, prove to be a DAWN case. It is the ratio of true positive cases to all positively flagged records. For DAWN, if the positive predictive value is low (i.e., there are many "false positives" relative to "true positives"), DAWN reporters would need to review a high number of records relative to the number of DAWN cases actually found. Thus, low positive predictive values increase the burden on the reporter.

An ideal screen has high sensitivity, specificity, and positive predictive value. In practice, sensitivity is often increased at the price of positive predictive value. Screens that are highly sensitive tend to capture a wide range of potential cases, and there are a number of false positives, resulting in lower positive predictive values. Conversely, screens with high positive predictive values tend to be more narrow, focusing on groups of cases that have a very high probability of meeting case criteria. However, because of the narrowness of the screen, true cases belonging to low probability groups are missed and sensitivity is low (A helpful overview of sensitivity, specificity, and positive predictive value can be accessed on the Medical University of South Carolina's website at: http://www.musc.edu/dc/icrebm/sensitivity.html; Fleiss,1981). In order to decide whether the log screening process is adequate, DAWN must weigh the cost of missing cases (as measured by sensitivity) versus the cost of reviewing additional records (as measured by positive predictive value).

For this limited field test of the ED log and ICD-9-CM screening methods, the redesign team visited two hospitals where: those methods are currently used, there was a sufficient volume of

cases to permit meaningful data analysis, and staff were agreeable to providing limited access to a full complement of medical records. The findings of those field tests are summarized here.[2]

Assessment of the Log Screen Method

The log screen method was assessed during a three-day site visit to an East Coast emergency department. Three members of the research team reviewed 1,032 medical records, which were all records available for the period from November 5 to November 20, 2000. Data sheets were filled out for all cases that made any mention of an illicit drug or any toxic reaction to a substance, including licit drugs or consumer products. The broad scope was needed to encompass both the current and proposed case definitions, as well as any future revision of the proposed definition. In addition to medical record data, the team collected the following information from all entries in the ED log for the study dates: presenting complaint, age, gender, and disposition. ED log entries were matched with medical records for analysis. Consistent with current data collection agreements with DAWN hospitals, medical record information was recorded only for cases meeting DAWN criteria; for non-reportable cases, the research team recorded only the patient's log entry.

The DAWN reporters' manual includes a list of presenting complaints often associated with DAWN cases. Reporters using a log screening method would begin with this list and modify it to better reflect the actual cases seen in their EDs. For the purpose of this assessment, data were reviewed and a list of presenting complaints was developed that maximized the sensitivity and specificity of the log screen for identifying cases meeting the current definition. That same list of complaints was then used to screen the records to identify cases meeting the proposed new case definition. Additional analyses assessed the number and type of complaints that would need to be added or dropped in order to maximize the sensitivity, specificity, and positive predictive value of the screen for the new case definition. A key concern was that, were the proposed case definition to be implemented, reporters might continue using the old list of presenting complaints in their screening procedure. It was therefore necessary to assess the extent to which that would impact identification of new cases, and the degree of effort that would likely be necessary to update all screening approaches currently in place system-wide.

After reviewing all charts and log entries, a modified list of presenting complaints was developed for use as a case screening tool.[3] The screen was then applied to the database, and charts containing any of the complaints included on that list were flagged. In total, the screen successfully identified 41 (68.3%) of the 60 cases meeting the current case definition. Thus, the sensitivity of the screening procedure was 68 percent, meaning that it missed 32 percent (19/60) of the DAWN cases identified by medical record review. This same screening tool successfully screened out 841 (90.8%) of the 926 cases that did not meet the current DAWN case definition. In other words, it identified 85 false positives and the specificity of the procedure was 91 percent. The predictive value of the screen (the percentage of correctly flagged cases among all flagged cases) was 41/126 = 32.5 percent. Thus, if a case was flagged by the list of complaints used, about one record out of three actually turned out to be a current DAWN case. These results are summarized in Table 4-11.

[2] A detailed description of procedures and analyses is beyond the scope of this chapter. Full task reports on the field tests are available from OAS upon request.

[3] Because this was a limited assessment, hospital characteristics are unique, and an explanation of procedures are beyond the scope of this report, full details are not presented here. The original task reports, including complete lists of complaints that were reviewed, listed in the DAWN-ED reporters' manual, and used in these analyses, can be obtained from OAS upon request.

Table 4-11. Sensitivity and Specificity of Log Screen Used in Field Test (Current Case Definition)

		Screen by Revised Criteria		
		Identified by Screen	**Ruled Out by Screen**	**TOTAL**
Medical Record Review	**Current Cases**	41 (68% of Current Cases)	19	60
	Not Current	85	841 (91% of non-DAWN cases)	926
	Total Reviewed	126	860	986
Admitted*		20	202	222
TOTAL		146	1,062	1,208

*Medical records were not available for patients who had been admitted to other units of the hospital; the implications of this missing information are discussed below.

Next, the same screening tool was applied in an attempt to identify cases meeting the proposed new case definition. Of the medical records reviewed, 91 met the new case definition criteria while 895 did not. The screening method successfully identified 74 (81.3%) of the 91 new DAWN cases. There were 17 false negatives (i.e., cases meeting the new definition but not flagged by the screen). The sensitivity of this procedure was 81 percent, meaning that the log screen missed 19 percent (17/91) of the DAWN cases identified by medical record review. The log screen successfully screened out 535 (59.7%) of the 895 cases that did not meet the new case definition. However, it also flagged 360 "false positives," or cases that should have been screened out—the specificity of the procedure was 60 percent. The predictive value of the screen was 74/434 = 17.1 percent. A reporter reviewing all of the medical records identified by the log screen would have found only 17 percent of them to be reportable to DAWN and 83 percent to be non-reportable. These findings are summarized in Table 4-12.

The proposed new definition is more sensitive (i.e., the screen identified 81 percent of the new DAWN cases compared to 68 percent of those meeting the current case definition) than the performance of the log screen criteria used in this study for the current DAWN case definition. However, the log screen used with the new definition proved to be much less specific – that is, it inaccurately flagged 40 percent of all non-cases as potentially reportable, compared to a false positive rate of only 9 percent for the current case definition. In the hospital serving as the study site for this test, a DAWN reporter using a log screen and the current case definition would have to review 126 medical records to identify 41 DAWN cases and would have missed 19 DAWN cases. Meanwhile, a reporter using a log screen and the proposed new case definition would have had to review 434 medical records to identify 74 reportable cases and would have missed 17 reportable cases. If this hospital were to continue to use a log screen once the case definition changes, the reporter's workload would increase more than three-fold, and the reporter would still miss 19 percent of the ED's reportable cases.

Table 4-12. Sensitivity and Specificity of Log Screen Used in Field Test (New Case Definition)

		Screen by Broad Net Criteria		
		Identified by Screen	**Ruled Out by Screen**	**TOTAL**
Medical Record Review	**New Cases**	74 (81% of New DAWN Cases)	17	91
	Not New Cases	360	535 (60% of all not-New Cases)	895
	Total Reviewed	434	552	986
Admitted*		20	202	222
TOTAL		454	754	1,208

* Medical records were not available for patients who had been admitted to other units of the hospital; the implications of this missing information are discussed below.

Assessment of the ICD-9-CM Screening Method

Testing the ICD-9-CM screening method presented substantial technical challenges. The test requires access to a facility's billing records as well as its medical records. To undertake this test in a current DAWN hospital, it would have been necessary to ask a billing clerk to develop and run repeated algorithms to screen for DAWN cases meeting the current and new case definition criteria. To obtain the volume of cases necessary to produce meaningful statistical analyses, a large hospital with many substance abuse cases was needed. To avoid the many operational difficulties involved in such a test, the redesign team enlisted the assistance of a research team in a large, urban, university hospital. Because of its affiliation with a university medical center, the hospital was accustomed to supporting research projects of this nature and was able to provide graduate research assistants to conduct the medical record reviews.

The research team reviewed all records generated in the ED for cases treated in the month of October 2000. If a case involved drugs, alcohol, or the inhalation of substances, the researchers provided the following data for each case:

- A case description copied verbatim from the medical record that described the presenting problem, the assessment, consultations, and/or toxicology results
- Age
- Nature of the drug/alcohol involvement (i.e., the "type of case" classification described above)
- Substance(s) involved
- Diagnoses
- Disposition at discharge

To ensure consistent application of the case definitions, all cases were coded by the redesign team (rather than the university's research assistants) for whether it met the current and/or new case definition. Because the case definition proposal had evolved by the time this study was conducted, the new case definition included underage drinking cases (which were not included in the log screen test conducted earlier).

The medical center also provided billing data on all cases seen in the month of October 2000. The billing data included ICD-9-CM codes for primary and secondary diagnoses. A single visit could involve documentation of as many as 15 ICD-9-CM codes. In total, the 5,792 ED episodes from October 2000 carried a combined total of 1,919 different ICD-9-CM codes. These codes were consolidated into 61 categories for the purpose of these analyses; categories were based on ICD-9-CM codes and their sub-codes. The categories were developed so as to cluster clinically meaningful conditions together, while attempting to maximize the number of categories that might be useful as a drug abuse screening tool. (For example, "drug dependence" and all of its associated ICD-9-CM codes were collapsed into a single category for analysis.) A total of 61 categories were developed. Billing records were matched with medical records, and a database was created to support the screen test. The sample was split in half using a random sample procedure. The first half of the sample was used to develop a list of predictor codes for the ICD-9-CM screen. Frequencies were run on the ICD-9-CM categories to identify any that included at least one DAWN case. These categories were then entered into a stepwise forward logistic regression analysis of all positive predictors. This process was designed to identify the groups of ICD-9-CM codes that best identified the current and new DAWN cases.

Logistic regression is a statistical technique used to find the best fitting model that describes the relationship between a dichotomous dependent variable (in this instance, DAWN-reportable versus not) and a number of independent variables. The method of maximum likelihood is used to determine values for unknown parameters in a linear model that maximizes the probability of obtaining the observed set of data. In this study, logistic regression was used to identify which of the 61 groups of ICD-9-CM codes were the best independent predictors of whether a case is reportable to DAWN.

Stepwise logistic regression involves the iterative testing of whether variables that have not yet been included in the logistic equation significantly increase the probability of obtaining the observed pattern of DAWN cases. Variables are added successively. First the best predictor is added to the equation, then the remainder of the variables are tested, and the next best predictor variable is added. As multiple variables are added to the equation, the independent predictive ability of any one of them can change. In order to ensure that only the best predictors are included, variables in the equation are tested after a new variable has been added. Variables in the equation that no longer have predictive power are deleted. The procedure of adding and testing variables in the equation continues until no additional variables add to the predictive power of the equation. More detailed information about logistic regression may be found in Hosmer and Lemeshow (1989).

Stepwise logistic regression usually identifies predictors that are associated with either group designated by the dichotomous variable (i.e., DAWN cases and non-DAWN cases). However, for this field test, predictors in the equation are those categories that will be used to identify medical records that need to be reviewed by reporters. Therefore, the model should focus on only those categories that are positively associated with status as a DAWN case. Reporters are less interested in a list of codes that rule out DAWN cases. Thus, variables that were *negative* predictors were excluded from consideration. Once the best predictors (categories) were identified from an analysis of the first half of the sample, they were used to

screen for potential DAWN cases in the second half of the sample. A total of 33 ICD-9-CM categories were retained for use in the screening process. A sensitivity and specificity analysis of this screening process was then conducted.

Through a stepwise forward regression of current case status on these 33 categories, it was found that five ICD-9-CM code categories independently predicted whether a case met criteria for the current definition. These were: drug abuse, alcohol abuse, poisoning by drugs, suicide by poisoning, and HIV. After the five predictor categories were identified, no other ICD-9-CM codes predicted reportability to DAWN at a level higher than chance (p<=.10). All else being equal, cases carrying one of the 47 ICD-9-CM drug abuse codes were 157 times more likely to meet the current case definition.

To test the sensitivity, specificity, and predictive value of the ICD-9-CM screen for current DAWN cases, these five categories were used to screen the second half of the sample for reportable cases. Medical record review indicated that there were 68 cases in this portion of the sample that met the current DAWN case definition. The five ICD-9-CM categories successfully identified 46 (68 percent) of 68 current DAWN cases. The sensitivity of this procedure was 68 percent, meaning that this screen missed 32 percent of the DAWN-reportable cases (22/68), or resulted in 22 "false negatives."

The same set of five ICD-9-CM code categories successfully screened out 2695 (95 percent) of the 2831 cases that did not meet current DAWN criteria. However, this screening process resulted in identification of 136 "false positives" (i.e., it failed to screen out these cases), and the specificity of the procedure was 95 percent.

The predictive value of this ICD-9-CM screen was 25 percent, calculated as the percentage of correctly flagged cases among all flagged cases (in this instance, 46/182). This means that if a case screens positive by the ICD-9-CM code categories specified, there is about one chance in four that review of the medical record will reveal that the case is reportable to DAWN. Based on these data, a DAWN reporter would have had to review the medical records of 182 cases flagged by the screen, and would have found 46 to be DAWN-reportable. The results of this analysis are summarized in Table 4-13.

Table 4-13. Performance of ICD-9-CM Screen (Current Case Definition)

		Screen by ICD-9-CM Criteria		
		Identified by Screen	**Ruled Out by Screen**	**TOTAL**
Medical Record Review	**Current Cases**	46	22	68
	Not Current	136	2,695	2,831
	Total	182	2,717	2,899

To develop and test screening criteria for the new case definition, it was necessary to create two additional ICD-9-CM code categories – alcohol abuse by a minor and alcohol abuse by persons 21 years of age and older. Only the former category meets the proposed criteria for the new case definition. Examination of the frequencies of cases captured by each of the 61 ICD-9-CM categories used for the above analyses, plus these two additional categories, revealed that there were new DAWN cases associated with 40 different ICD-9-CM code categories.

It is important to note that all cases under age 21 with an alcohol abuse code met the criteria for the new case definition based on a review of their medical records. Accordingly, this category was a perfect predictor and was included in the screening criteria. However, this category could not be entered into a logistic regression, because there was no variation in the dependent variable. The other best predictors were identified via a stepwise forward regression of new case status on the remaining 39 ICD-9-CM code categories, using the first half of the sample. These analyses identified seven additional categories that independently predicted whether a case met criteria for the proposed new case definition. These were: drug abuse, poisoning by drugs, adverse drug reactions, HIV, rashes, hives, and drug dermatitis.

Table 4-14 presents the results of the screening procedure when the eight ICD-9-CM categories were applied to the second half of the sample (an independent sample). Medical record review indicated that 80 cases met criteria for the proposed new case definition among the sample. The screening procedure successfully identified 57 (71%) of the 80 DAWN cases. The sensitivity of this procedure was 71 percent, meaning that the screening procedure specified by the manual missed 29 percent of the DAWN-reportable cases (23/80), resulting in 23 "false negatives."

The same screening criteria successfully screened out 2709 (96 percent) of the 2819 cases that did not meet the new case definition. However, this resulted in identification of 110 "false positives" – that is, the ICD-9-CM code categories failed to screen out these cases. The specificity of the procedure was 96 percent.

Table 4-14. Performance of ICD-9-CM Screen (New Case Definition)

		Screen by ICD Criteria		
		Identified by Screen	**Ruled Out by Screen**	**TOTAL**
Medical Record Review	**New Cases**	57	23	80
	Not Cases	110	2,709	2,819
	Total	167	2,732	2,899

The positive predictive value of the ICD-9-CM screen for the new case definition was 34 percent, calculated as the percentage of correctly flagged cases among all flagged cases (in this instance, 57/167). This means that if a case screens positive by the ICD-9-CM criteria specified, there is about one chance in three that review of the medical record will confirm that the case is reportable to DAWN. In this hospital, the DAWN reporter would have had to review the medical records of the 167 cases flagged by the screening procedure, and would have found 57 to be DAWN-reportable.

As shown, the ICD-9-CM screen optimized for this hospital still missed a substantial number of cases, although it would reduce the burden of reviewing medical records. Comparing the performance of the ICD-9-CM screen criteria for the current case definition with criteria targeting the proposed new definition, it is clear that they are quite similar in their ability to detect and rule out DAWN cases. In other words, moving from the current case definition to the proposed case definition seems to have relatively little implication for the ICD-9-CM screen. Of greater concern is the underlying sensitivity and utility of the screen itself. Decisions about whether to continue to employ ICD-9-CM screening methods must include consideration of whether undercounts of this magnitude are acceptable and whether the resources to develop, assess, and refine the ICD-9-CM screen are available.

Discussion

A considerable difficulty in conducting the log and ICD-9-CM screening tests was an inability to gain access to 100 percent of the medical records for patients treated in the ED during the study period. Such difficulty is typical of the problems involved in hospital data collection and DAWN's system. Charts will physically move to different sections of the hospital as patients are moved to different units or as clinicians require them. In addition, hospitals have idiosyncratic methods for tracking patient flow and storing medical records. DAWN hospitals that collect data through screening procedures are particularly idiosyncratic; most are not able to use 100 percent medical record review, either because reporters cannot access all of the records, or because there are too many charts to review in order to identify a relatively small number of cases. DAWN procedures seem to value the collection of data over the systematic application of case identification methods. While this may be practical, it introduces complications into data quality assessments and estimation procedures. Because there is no systematically documented information about the screening processes and the hospitals that employ them, it is difficult to know what DAWN is actually collecting, and what is being missed.

A significant data collection challenge faced by DAWN reporters is gaining access to *all* ED charts. Equally challenging is determining what proportion of charts is inaccessible. The development of case identification screening methods does not solve this problem. Screening methods may only provide a false sense of security. The development of valid, useful, and accurate screening criteria requires access to a known proportion of the ED charts for both initial development of the screening tool and periodic review of its performance. Before implementing any data collection in a hospital, there must be a careful assessment of whether medical record access is adequate. Only then can various data collection strategies be evaluated. Because of the difficulty involved in developing, assessing, and refining ICD-9-CM screening, the redesign team strongly recommended that alternative data collection strategies be considered. Available evidence suggests that DAWN would greatly benefit from a concerted effort to: systematically assess reporter access to medical records, evaluate the adequacy of current log and ICD-9-CM screening procedures, and develop alternatives to inadequate procedures (including replacement of deficient hospitals) where needed.

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