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Study of Underreporting of Recreational Boating Accidents

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ACRONYMS LIST

AAAM	Association for the Advancement of Automotive Medicine
AHRQ	Agency for Healthcare Quality and Research
AIS	Abbreviated Injury Scale
BAR	Boating Accident Report
BARD	Boating Accident Report Database
BLA	State Boating Law Administrator
CDC	Centers for Disease Control and Prevention
CFOI	Census of Fatal Occupational Injuries
DHS	U.S. Department of Homeland Security
DOT	U.S. Department of Transportation
ED	emergency department
FHWA	Federal Highway Administration
HHS	U.S. Department of Health and Human Services
HCUP	Healthcare Cost and Utilization Project
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
MAIS	Maximum AIS
MCOD	Multiple Causes of Death (MCOD)
MISLE	Marine Information for Safety and Law Enforcement
NASBLA	National Association of State Boating Law Administrators
NAMCS	National Ambulatory Medical Care Survey
NCHS	National Center for Health Statistics
NHAMCS	National Hospital Ambulatory Medical Care Survey
NIS	National Inpatient Sample
NRBS	National Recreational Boating Survey
NTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board

NVSS	National Vital Statistics System
OMB	U.S. Office of Management and Budget
PIRE	Pacific Institute for Research and Evaluation
QALY	quality-adjusted life year
SEDD	State Emergency Department Databases
SID	State Inpatient Databases
SME	subject matter expert
SRG	Strategic Research Group
USCG	U.S. Coast Guard
WTP	willingness to pay

EXECUTIVE SUMMARY

The U.S. Coast Guard (USCG) requires accurate information about the frequency and consequences of recreational boating accidents.[1] The purpose of this effort is to compare existing accident data maintained in USCG's Boating Accident Report Database (BARD) to similar data available in other public and private sources. Based on this comparison, we suggest adjustments to the BARD data in order to provide more accurate estimates of the frequency and consequences of historical accidents. We also demonstrate how analysts should make these adjustments when estimating the benefits of proposed regulations.

This work enhances earlier efforts by USCG to develop multipliers. In 2011, USCG developed a set of nationally-applicable multipliers to adjust reported fatalities and nonfatal injuries in BARD (IEc and Robinson 2011). However, the authors were unable to identify publicly-available data sources reporting property damages from boating accidents for comparison to property damages reported in BARD. More recently, USCG obtained information from an insurance company (Insurance Company "X") describing historical boating accidents and related claims payments in the states of Florida and Minnesota.

Using data obtained from Insurance Company "X", we find that BARD data underreport property damage resulting from recreational boating accidents in Florida and Minnesota. We also use data from the Healthcare Cost and Utilization Project (HCUP) to demonstrate that nonfatal injuries are also under reported in Florida, and within the ranges previously identified in IEc and Robinson (2011). Similar analysis for Minnesota was not feasible due to limitations in the data reported to BARD. Finally, based on data obtained from the National Vital Statistics System (NVSS), we confirm that BARD remains the best source of information about recreational boating fatalities.

Exhibit ES-1 summarizes the multipliers developed in this report and our final recommendations. For reference, the first column presents the multipliers for fatal and nonfatal injuries developed in IEc and Robinson (2011). In the second column, we present the results of our analysis of data describing boating accidents in Florida, where available data supports the development of multipliers for fatal and nonfatal injuries, as well as property damage. For Minnesota, we developed multipliers for property damage

[1] Note, the term "accident" is no longer preferred in public health injury prevention discourse. However, within boating, the term is still in use, though several actions have been taken to work towards adoption of the term "occurrence" in place of accident. Adoption (and subsequent use) of the terms "occurrence" or "incident" has not yet been formalized through USCG procedures. Therefore, this report uses the term "accident" in several places in order to maintain consistency with existing USCG products and data terminology to avoid confusion.

information available in BARD. In the final column, we present the multipliers that USCG should apply when using BARD data in regulatory analyses based on collective information provided in the three prior columns.

EXHIBIT ES-1. SUMMARY OF BARD MULTIPLIERS AND RECOMMENDATIONS FOR USE IN ANALYSIS

DAMAGE CATEGORY	IEC AND ROBINSON (2011)	FLORIDA ANALYSIS	MINNESOTA ANALYSIS	RECOMMENDED MULTIPLIER FOR USCG'S USE IN REGULATORY ANALYSIS
Fatalities	1	1	N/A	**1**
Injuries				
Minor	120	N/A	N/A	**120**
Moderate	1.5 – 120*	30.4*	N/A	**1.5 - 120**
Serious	1.5 – 1.7	1.65	N/A	**1.5 - 1.7**
Severe	1.5 – 1.7	1.65	N/A	**1.5 - 1.7**
Critical	1.5 – 1.7	1.65	N/A	**1.5 - 1.7**
Property Damage	N/A	7.27	21.77	**7.27 - 21.77**

Sources: IEc and Robinson (2011) and IEc analysis using data sources presented in this report. Cells marked "N/A" denote instances where analysis was not conducted due to data limitations or analytic decisions.
Note:
* Our analysis assumes that any nonfatal injuries not resulting in hospitalization were treated in an emergency department setting and compares injury counts in BARD to emergency department visits in HCUP. However, some injuries identified in BARD as "moderate" may have been treated in other settings (e.g., doctor's offices). Thus, this multiplier is likely understated.

IEc and Robinson (2011) were able to identify a national data source that allowed them to compare all non-admitted injuries requiring treatment beyond first aid to a more expansive dataset including doctor's office visits. This comparison resulted in a multiplier of 120.

We propose that fatalities identified in BARD should not be adjusted, as BARD is the best source of this information. For each minor nonfatal injury identified in BARD, our recommended multiplier suggests that 120 such injuries may have occurred. Similarly, for each moderate injury, IEc and Robinson (2011) suggests that between 1.5 and 120 injuries actually occurred. For serious, severe, and critical injuries, the multiplier is between 1.5 and 1.7. Our updated analysis for Florida specifically identifies nonfatal injury multipliers within these ranges. Finally, we assume that for every dollar of property damage reported in BARD, between 7.27 and 21.77 dollars of damage may have occurred.

When considering the application of the recommended multipliers, two principal sources of uncertainty should be recognized:

- The multipliers from IEc and Robinson (2011) are more than 10 years old. Changes in reporting requirements or processes (both to BARD and at the state level) in the intervening years may have affected actual underreporting. For example, if more state resources are devoted to investigating and reporting boating accidents, the actual multipliers may be lower. Similarly, if resources for investigations have declined, the multipliers may be overstated. The fact that the Florida-specific nonfatal multipliers calculated for this current effort fall within the ranges of the 2011 report provides reassurance that the multipliers from IEc and Robinson (2011) are still reasonable and the best available information for use in national-level analyses.
- The property damage multipliers are based on data from a subset of the Florida and Minnesota recreational boating population obtaining insurance from Insurance Company "X". We do not have any *a priori* reasons to believe that claims adjustment practice or accident reporting rates are likely to differ based on insurance carrier (and therefore result in a significantly different value if all other carriers/boats were included in the analysis). We present a recommended multiplier range bound by the Florida and Minnesota property damage multipliers and interpret these relationships to be sufficiently representative to apply to BARD accident data generally.

Exhibit ES-1 suggests that the multiplier applied to minor and moderate injuries can have a significant impact on benefit estimates. Ideally, USCG would conduct additional research to obtain more precise estimates for these injury categories. However, the lack of detail available to USCG regarding treatment location (e.g., hospitalization, outpatient setting) for BARD-reported injuries is a significant limitation. USCG may need to conduct primary research, through boating surveys or other means, to obtain more precise estimates of minor and moderate injuries.

Recreational Boating Underreporting Multiplier Tool

In coordination with the analysis presented in this report, IEc prepared a Microsoft Excel-based tool to assist CG-REG-1 analysts preparing regulatory analyses. Please contact Evan Morris to access the tool.

CHAPTER 1 | INTRODUCTION

To fulfill its role in protecting the safety of recreational boaters, USCG develops rules aimed at limiting the frequency of boating accidents as well as the severity of damage they cause. Under Executive Order 12866 (Clinton 1993), the USCG is also responsible for evaluating the incremental costs and benefits of the rules it promulgates to determine if each rule will result in positive net benefits to society. Both tasks require accurate information about the recreational boating accidents USCG seeks to limit, and therefore high-quality data characterizing the fatalities, nonfatal injuries, and property damage resulting from these accidents.

The purpose of this effort is to compare existing accident data maintained in BARD to similar data available in other public and private sources. Based on this comparison, we suggest adjustments to the BARD data in order to provide more accurate estimates of the frequency and consequences of historical accidents. We also demonstrate how analysts should make these adjustments when estimating the benefits of proposed rules revising existing recreational boating regulations.

This introductory chapter provides background information about current requirements for reporting boating accidents to USCG. It also describes prior efforts to estimate the degree of underreporting in BARD. Finally, we describe the scope of this current effort and the organization of the remainder of the report.

1.1 BACKGROUND

Under 46 U.S.C. 13102, Congress requires that the USCG's Boating Safety Division (CG-BSX-2) carry out the National Recreational Boating Safety Program. The Program's mission is to ensure that the public has a safe, secure, and enjoyable recreational boating experience by implementing programs designed to minimize the loss of life, personal injury, and property damage while cooperating with environmental and national security efforts. USCG achieves its objectives through information sharing, voluntary programs, and Federal regulation. In addition, it works closely with State Boating Law Administrators (BLAs) to coordinate and enhance State and Federal laws and programs.

USCG requires information regarding current (baseline) risks associated with recreational boating for several purposes. These data assist in the identification of activities or practices resulting in the greatest number of fatal and nonfatal injuries, supporting the prioritization of programs or policies designed to reduce accidents. Furthermore, accurate annual data allow USCG to evaluate progress made toward its goals.

In addition, and of particular importance to USCG's Standards Evaluation and Analysis Division (CG-REG-1), the Agency requires information on accidents to measure the incremental risk reductions resulting from proposed regulations. Specifically, Executive Orders 12866, *Regulatory Planning and Review* (Clinton 1993), and 13563, *Improving Regulation and Regulatory Review* (Obama 2011), direct Federal agencies to estimate the costs and benefits of significant regulatory actions.[2] In its guidance to Federal agencies defining "best practices" for the preparation of economic analyses, the U.S. Office of Management and Budget (OMB) directs agencies to measure the benefits and costs of proposed regulations against a baseline. The baseline is defined as "the best assessment of the way the world would look absent the proposed action" (OMB 2003). In other words, the baseline represents current and projected future risk levels associated with recreational boating in the absence of intervention.

To estimate baseline risk levels, USCG collects data through Boating Accident Report (BAR) forms. Federal and State regulations require boat owners/operators to complete BAR forms and submit them to the State BLA within 48 hours to 10 days of an accident, depending on the circumstances (33CFR173.55). Depending on the accident, and on whether authorities are present at the time of the incident, State BLAs or other State authorities may conduct an investigation and record additional information on the incident. BLAs submit BAR data and other relevant information from any investigations to USCG electronically.[3] These data are compiled into BARD.[4]

The current six-page Federal BAR form requests detailed information on all aspects of an incident. The data requested include the number of fatal and nonfatal injuries (categorized by primary injury type and body part affected), causes of injury, and property damage. Characteristics of the accident, the vessel, and its operators are also reported.

Not all accidents involving recreational vessels are reportable to USCG. Under Federal regulations, the operator of any numbered vessel that was not required to be inspected or a vessel that was used for recreational purposes is required to file a BAR when, as a result of an occurrence that involves the vessel or its equipment (USCG 2020a):[5]

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[2] A "significant regulatory action" is defined as "a rule that may: (1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health and safety, or State, local, or tribal governments or communities; (2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or (4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order" (Clinton 1993). Although most of USCG's regulations are ultimately determined not to be significant actions, it prepares estimates of the benefits and costs of each proposed regulation to confirm this conclusion.

[3] Approximately half of the incidents recorded in BARD include the source of the accident report. Based on an informal review of these records conducted for IEc and Robinson (2011), USCG estimated that data were recorded on a BAR form for approximately 33 percent of incidents. For another 38 percent, data were obtained from a BAR form and an investigation. For the remaining 29 percent of incidents, data were entered into BARD based only on information from an investigation.

[4] Data reported to BARD are obtained from two additional sources: (1) reports of investigations of fatal boating accidents that occurred on waters under Federal jurisdiction; and (2) reports received from news media sources where no investigative data were provided by the State (USCG 2020).

[5] Individual States may have reporting requirements that are more stringent; however, at a minimum, they must collect the data elements required by USCG, as set out in 33 CFR 173 (USCG 2020a).

1. A person dies;
2. A person disappears from the vessel under circumstances that indicate death or injury;
3. A person is injured and requires medical treatment beyond first aid;
4. Damage to vessels and other property totals $2,000 or more; or
5. There is a complete loss of any vessel.

Generally, accidents occurring while the vessel is docked or moored, or while it is on a trailer, are not reportable.

In 2011, IEc conducted interviews with USCG, the National Association of State Boating Law Administrators (NASBLA), and former BLAs to better understand accident reporting. These interviews revealed that the degree to which owners/operators report accidents varies depending on the priorities of each State and resources used to educate boaters and investigate accidents (IEc and Robinson 2011). Most agreed that the reasons for noncompliance are owner/operators' lack of awareness of the requirement to report, followed by fear of incriminating themselves and lack of knowledge of how to report (NASBLA 2008a).[6] States vary in how they address these problems.

- Some States are more proactive than others about alerting the public of the need to report and investigating incidents where no BAR is filed. Within States, the ability to pursue these types of activities may change from year to year due to budget cuts and changes in the priorities of new administrations (IEc and Robinson 2011).[7,8]
- An older survey of BLAs revealed that while most States have some combination of civil and/or criminal penalties for failing to report a boating accident, these penalties are largely unenforced (NASBLA 2008b).

In addition, certain data elements or requirements are subject to interpretation by BLAs or are not consistently reported.[9] As a result, differences in estimates of the number of

[6] CG-BSX-2 reconfirms that these are the key reasons for underreporting in its draft report comparing accident data provided by Insurance Company "X" with data in BARD (USCG 2021).

[7] Nevada, for example, passed a statute (488 NRS §550) in 1993 requiring the insurance industry to alert boat owners of their responsibility to submit a BAR when accident claims were made against insurance policies and to alert the BLA of the incident. The BLA worked with insurers to provide materials to encourage compliance with the law and followed-up with an investigation if no BAR was submitted. Within 2 years of the law's passage, the number of BARs received annually went up by 60 percent (Messman 2008). However, this process was labor intensive, and subsequently, priorities within the State shifted (Personal communication with F. Messman, on March 3, 2011, as cited in IEc and Robinson (2011)).

[8] Of particular relevance to this effort, in Florida, the Florida Fish and Wildlife Conservation Commission (FWC) is the primary agency responsible for data collection. FWC receives fewer than 5 percent of its cases from local agencies. Most of the FWC officers have 6 to 10 years of experience, and they receive standardized, in-house training. The State also maintains its own reporting system and provides a platform for the public to report accidents electronically. FWC reports receive at least three layers of review and approval before being submitted to USCG, and the State promotes reporting requirements through its public relations officer and through officer contact with the public (USCG 2021).

[9] For example, many States do not report whether nonfatal injuries resulted in hospitalization (IEc and Robinson 2011). In addition, the definition of "first aid," which triggers the need to report, is interpreted differently across States (IEc and

injuries derived from BARD may be influenced as much by changes in States' efforts to enforce compliance with reporting requirements as in actual changes in the number of accidents that occur. Furthermore, interstate differences complicate extrapolation of risk rates from one State to another.

1.2 PREVIOUS EFFORTS TO ESTIMATE UNDERREPORTING IN BARD

USCG has undertaken a number of efforts to supplement BARD with data from other sources as well as to determine the extent to which the data it contains are accurate and reliable. Three past efforts suggest that BARD does not capture all recreational boating-related accidents. These efforts include a survey of boaters conducted in 2002 by the Strategic Research Group (SRG) (2003); an analysis of national and State health care databases conducted by Lawrence et al. (2006); and a similar analysis conducted by IEc and Robinson (2011). These efforts are summarized below.[10]

1.2.1 SRG SURVEY (SRG 2003)

USCG engaged SRG to conduct the National Recreational Boating Survey (NRBS), which was published in 2003. The survey was intended to assist Agencies in developing intervention strategies to reduce boating risk. It included questions about types of boats used and activities associated with boat outings (e.g., swimming, water skiing), frequency of boating activity, safety practices (e.g., life jacket usage, safety training through a boating safety course), the number of accidents experienced by boaters, and the causes and consequences of those accidents.

A total of 25,547 surveys were completed by phone or mail, based on a stratified sample of boaters who do and do not own boats in 50 States and the District of Columbia. Survey respondents were asked to report boating activity undertaken between September 2001 and September 2002. For accidents, the survey provides information describing the characteristics of the individuals involved and the conditions under which the incidents occurred, but not on the type or severity of the injuries.

The survey results suggest approximately 2 percent of boat operators were involved in an incident that resulted in damage to a boat or property and 1 percent of boat operators were involved in an incident where one or more people were seriously injured and required medical attention beyond first aid. When weighted to reflect the overall boating population, the survey responses suggest that 550,371 boat operators experienced an

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Robinson 2011). For example, whether onsite treatment of cases of hypothermia provided by emergency medical technicians or paramedics qualifies as "medical treatment beyond first aid" is subject to debate.

[10] Examples of other studies include the *1998 National Recreational Boating Survey* (JSI Research & Training Institute, Inc., 2000). The survey collected information on boating exposure rates and the level of use of safety equipment and safety-oriented practices. Another example reflects data collected from 2001 through 2005, when the Emergency Nurses Association and the Injury Prevention Institute/EN CARE conducted surveys of patients in emergency departments at 75 hospitals in order to understand the behaviors and causes leading to recreational boating injuries (Emergency Nurses Association *et al.*, no date). Neither study provides estimates of annual, nationwide injuries for comparison to BARD. A third report summarizing the results of the Recreational Boating Accident Register (R-BAR) program, a mid-1990's collaboration between USCG and the insurance industry, is discussed in IEc and Robinson (2011).

incident where one or more boats or property were damaged, and 271,470 boat operators experienced incidents resulting in injuries requiring medical attention beyond first aid during those 12 months.

The results suggest that BARD under-estimates annual injuries by two orders of magnitude. BARD reported 4,274 nonfatal injuries in 2001 and 4,062 in 2002 (USCG, 2003a and 2003b). While SRG's estimates of boating incidents appear much higher than estimates from BARD, the survey does not provide enough detail on the nature or type of injuries for use in economic analysis. The reasons why this estimate is high in comparison to other sources, discussed below, is also unclear.

1.2.2 LAWRENCE ET AL. (2006)

In 2006, USCG published a second study focused specifically on quantifying the magnitude of underreporting in BARD and developing a method for adjusting its baseline injury estimates. The study was prepared by Bruce A. Lawrence and Ted R. Miller of the Pacific Institute for Research and Evaluation (PIRE) and L. Daniel Maxim of the U.S. Coast Guard Auxiliary (hereafter referenced as Lawrence et al., 2006). Advice and oversight were provided by an external review board including economists, statisticians, and physicians from USCG, the National Transportation Safety Board (NTSB), the National Highway Traffic Safety Administration (NTSA), the Federal Highway Administration (FHWA), NASBLA, and the private sector.

Lawrence et al*.* (2006) use existing national and State health databases to estimate the number of boating-related injuries requiring varying types of treatment, which the authors then compare to BARD. These databases are not specific to boating; rather they are developed for use by public health researchers for a wide variety of purposes, as described in greater detail in Chapter 2. Lawrence et al. (2006) use these data sources to estimate recreational boating injuries in the year 2002. While they characterize their work as "exploratory," it involves detailed analysis of data from several sources. The authors begin with state-level data, then aggregate to national totals, relying on the following sources:

- For fatalities, they rely on data from the Multiple Causes of Death (MCOD) system maintained by the Centers for Disease Control and Prevention (CDC) National Center for Health Statistics. MCOD, referred to more generally as the National Vital Statistics System (NVSS), is a census of U.S. deaths based on death certificates.
- For nonfatal injuries resulting in hospitalization or emergency department (ED) treatment, they relied on two data sets from the HCUP maintained by the U.S. Department of Health and Human Services (HHS) Agency for Healthcare Quality and Research (AHRQ) – the State Inpatient Database (HCUP-SID) and the State Emergency Department Databases (HCUP-SEDD).
- For nonfatal injuries treated in other locations (such as doctors' offices or clinics), they rely on previous research estimating the number of such injuries relative to injuries treated in EDs based on data from the National Hospital Ambulatory

Medical Care Survey (NHAMCS) and the National Ambulatory Medical Care Survey (NAMCS). NHAMCS and NAMCS are conducted by CDC's National Center for Health Statistics (NCHS).

For fatalities, the authors found that their research supports the BARD-based estimates, which – at the time – USCG recommended adjusting upwards by one percent to account for underreporting. These adjusted fatalities totaled 758 in 2002. For nonfatal, hospital-admitted injuries, the authors' estimates were higher than the BARD estimates by about 25 percent; they found 2,181 nonfatal, hospital-admitted injuries compared to 1,752 in BARD in 2002. The difference was much larger for nonfatal, non-admitted injuries: more than 30,000 compared to 2,309 in BARD. However, the authors noted that more work was needed to verify these estimates.

1.2.3 IEC AND ROBINSON (2011)

In 2011, USCG engaged IEc to conduct a new study examining data on the consequences of recreational boating accidents and developed estimates of underreporting. Similar to Lawrence et al. (2006), IEc and Robinson (2011) used existing national and State health databases to estimate the number of boating-related injuries requiring varying types of treatment, which the authors then compared to BARD. However, rather than building up estimates from state-level data, we compared national-level health data to national estimates in BARD. We also evaluated approaches for valuing avoided fatalities and injuries in regulatory assessments. Finally, we investigated alternative sources of information regarding the value of property damage resulting from recreational boating accidents. Specifically:

- For fatal injuries, like Lawrence et al. (2006), we relied on the NVSS. We found that the USCG's data in BARD on incidence appear reasonably accurate. To value these fatalities, USCG applied a VSL of $6.3 million based on direction provided by the U.S. Department of Homeland Security (DHS) General Counsel.
- For nonfatal injuries, we compared data in BARD to data obtained from three databases: HCUP-National Inpatient Sample (NIS) (hospital admissions); NHAMCS (ED visits and outpatient care); and NAMCS (visits to office-based physicians). The study suggests underreporting increases as injury severity decreases. Injuries severe enough to result in hospitalization are underreported by less than a factor of two. Less severe injuries may be underreported by much larger amounts (factors of 1.5 to 120). Monetary valuation of these injuries is challenging because suitable estimates of individual willingness to pay (WTP) are not available for nonfatal injury risk reductions. Instead, government agencies and researchers often rely on one of two approaches as rough proxies: averted costs with estimates of quality-of-life impacts (generally reported as quality-adjusted

life years or QALYs); or estimates relying solely on averted medical costs and lost productivity.[11]

- For property damage, we were unable to locate an alternative, comprehensive source of information that was easily accessible. We suggested that USCG consider working with data firms supporting the insurance industry, such as Insurance Services Office, to obtain summary information describing the number and characteristics of boating claims. We also suggested conducting surveys of the insurance industry or recreational boaters.

Finally, we also included an appendix exploring the degree to which underreporting varied by State. Using the HCUP-SID, we compared BARD data to hospital discharge records for eight different States. We found that the use of national multipliers for policies that disproportionately affect certain States may be inappropriate because they ignore substantial differences in State reporting. Some States appear to capture most nonfatal, boating-related injuries resulting in hospitalization in BARD, while others appear to face greater challenges in collecting reliable data on boating-related injuries. Also, multipliers vary significantly by year within some States.

1.3 TASK OBJECTIVES AND REPORT OVERVIEW

USCG is interested in building on prior work to more accurately characterize the number of accidents, fatalities, and nonfatal injuries reported in BARD. It is also interested in updating the monetary values it assigns to nonfatal boating accidents, particularly the value associated with property damage, as part of its regulatory analysis process.[12]

Because of the variability in the quality of data reported by individual States and constraints on data describing property damage, this effort focused on state-level information and adjustments, rather than national estimates. Specifically, our analysis focused exclusively on data related to accidents occurring in Florida and Minnesota.[13] Then, because the multipliers in IEc and Robinson (2011) are currently used by USCG to adjust BARD data for regulatory analysis purposes, we compare the updated and State-specific results to those existing estimates and propose potential updates to the standard approach.

The report documents the results of our analysis. Specifically:

[11] Note that USCG currently applies disutility factors to the VSL to estimate values for avoided nonfatal injuries. These disutility factors were developed by DOT and are based on monetized estimates of lost QALYs for injuries of varying severity (DOT 2021).

[12] DHS directs component agencies, including USCG, to use estimates developed by DOT to value avoided fatalities and nonfatal injuries in its regulatory assessments (see, for example, DHS (2021)).

[13] Working in partnership with Insurance Company "X", USCG obtained data describing boating accidents in the States of Florida and Minnesota. In the first year of this effort (2021-2022), we focused on developing adjustments to BARD for accidents occurring in Florida. We analyzed data and information related to Minnesota in the first option year of this contract (2022-2023).

- **Chapter 2** describes our analysis of potential underreporting of fatalities occurring in Florida and nonfatal injuries occurring in Florida and Minnesota and makes recommendations for adjusting BARD data;
- **Chapter 3** describes our analysis of potential underreporting of property damage in BARD for accidents occurring in Florida and Minnesota and makes recommendations for adjusting BARD data;
- **Chapter 4** provides an illustrative example of how to apply these recommendations to estimate the total value, in monetary terms, of risk reductions resulting from a hypothetical regulation;
- **Appendix A** provides the results of a literature review conducted to explore existing studies relevant to this effort; and,
- **Appendix B** summarizes our review of medical databases containing potentially useful information on the number and types of injuries resulting from recreational boating accidents.

CHAPTER 2 | FATALITIES AND INJURIES

This chapter discusses the methodologies, data selection, analysis, and results associated with multiplier development for both fatal and nonfatal recreational vessel-related injuries. Specifically, we estimate the total quantity of underreporting in Florida for boating accidents not captured in BARD and report separately our analysis of fatalities and nonfatal injuries for the years 2014 to 2019. For nonfatal injuries, we distinguish between injuries resulting in hospitalization and those resulting in emergency department (ED) visits. In each section, we begin by describing the data selection process and database(s) in greater detail. Then, we compare our results to BARD and present multipliers to adjust for any underreporting.

We attempted a similar exercise for Minnesota but discovered that BARD data essential to our nonfatal injury approach was largely missing, rendering a comparison infeasible (see Section 2.2.4 for details). While a comparison of information on fatalities may have been possible for Minnesota, the fatality analysis for Florida provided corroborating evidence that the multipliers developed by IEc and Robinson (2011) still hold, suggesting additional state-level analysis was of limited use. Therefore, this chapter presents analysis of Florida data, with a discussion of the potential limitations of replicating the approach in other States.

2.1 FATAL INJURIES

2.1.1 METHOD

We began our fatal injury analysis by researching potential databases for comparison to BARD. We first updated the annotated bibliography from the IEc and Robinson (2011) report, identifying new sources through Google Scholar searches, other online bibliographic databases, and recommendations from USCG staff (see Appendix A for the full annotated bibliography). We also conducted outreach to State government agencies (e.g., Florida Fish and Wildlife Conservation Commission). While dozens of health databases were identified, we focused on those that recorded fatalities by cause of injury. In total, we evaluated 16 databases that met this basic criterion. Additional detail on these databases can be found in Appendix B. We then considered three additional criteria to determine which databases were appropriate for comparison to BARD data:

1. Geographic coverage was at the state level and included the state of Florida;
2. Data included codes identifying "boating" as the cause of injury or death;
3. The severity of the injuries was addressed, or the data included descriptions of injuries by type.

2.1.2 DATA AND ANALYSIS

Based on these criteria and after completing the overview of State injury datasets that contain information on recreational boating fatalities, we selected the NVSS as the preferred data source. These data are also referred to as the Multiple Causes of Death (MCOD) system, which is maintained by the CDC National Center for Health Statistics. NVSS is a census of U.S. deaths based on death certificates. The NVSS registers virtually all deaths nationwide by State and is the most comprehensive source of mortality data for the U.S. population.

Starting with 1999, NVSS data are coded using the International Classification of Diseases, Tenth Revision, Clinical Modification (hereafter, ICD-10-CM). The ICD-10-CM includes an external cause of injury code that describes the circumstances of a patient's injury.[14] For all health databases that use ICD-10-CM codes, the relevant boating external cause-of-injury injury codes are: V90 (Accident to Watercraft Causing Drowning and Submersion); V91 (Accident to Watercraft Causing Other Injury); V92 (Water-Transport-Related Drowning and Submersion without Accident to Watercraft); V93 (Accident on Board Watercraft without Accident to Watercraft, Not Causing Drowning and Submersion); and V94 (Other and Unspecified Water Transport Accidents). Additionally, there is a layer of sub-codes that identify the type of watercraft. The sub-code categories include: merchant ship; passenger ship; fishing boat; other powered watercraft; sailboat; canoe or kayak; inflatable craft (non-powered); water skis; other unpowered watercraft; and unspecified watercraft. Even though ICD-10-CM coding includes this level of vessel specificity, the publicly available NVSS dataset for Florida did not designate type of watercraft. Thus, we were unable to exclude incidents involving commercial vessels.

BARD data were provided by USCG in Microsoft Access format, with separate databases for each year organized by accident, vessel, fatalities, and injuries. We transferred the databases for 2014 to 2019 into Excel, filtered out any accidents that did not take place in Florida, and combined the datasets into one Excel workbook for each year. We organized the data according to accident, vessel, fatality, or injury in separate spreadsheets. We used BARD fatality data presented at the individual level for this analysis (i.e., each line of data represents one fatally injured person), which is directly comparable to the NVSS data.

To account for potential underreporting in BARD, we developed multipliers by dividing the number of fatal, vessel-related injuries for each year of Florida NVSS data by the number of fatal injuries for each year of BARD data.

2.1.3 RESULTS

Exhibit 2-1 below displays the fatality counts and implied multipliers. For example, 35 fatal injuries reported in NVSS in 2014 divided by 70 fatal injuries reported in BARD in 2014 results in a multiplier of 0.50. However, as there are more fatalities reported in

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[14] University of North Carolina Injury Prevention Research Center. 2014. "E-code Fact Sheet". Accessible at: https://ncdetect.org/wp-content/uploads/sites/13428/2016/12/CCHI_E_CodeFactSheetJan2014.pdf

BARD than in NVSS, the multiplier acts inversely and would reduce the BARD estimate. As we explain in subsequent sections, we believe BARD to be the most accurate record of fatalities, and therefore no adjustments are required.

EXHIBIT 2-1. BOATING-RELATED FATAL INJURIES IN FLORIDA, 2014-2019

YEAR	FATAL INJURIES IN NVSS (a)	FATAL INJURIES IN BARD (b)	MULTIPLIER (c = a/b)
2014	35	70	0.50
2015	39	52	0.75
2016	35	70	0.50
2017	39	66	0.59
2018	38	57	0.67
2019	38	62	0.61
Total	224	377	0.59

As shown above, for every one fatality reported in BARD between 2014 and 2019, there were 0.59 fatalities reported in NVSS. This relationship is similar to that found in the IEc and Robinson (2011) report. We expect NVSS estimates to be lower for several reasons. First, research has shown that death certificates alone fail to properly record causes of fatalities. For example, the Bureau of Labor Statistics Census of Fatal Occupational Injuries (CFOI), a federal and State cooperative program that has been implemented in all 50 States and the District of Columbia since 1992, reports comprehensive counts of fatal work injuries using multiple data sources (BLS, 2010). A 1997 study of occupational injuries found that death certificates were correctly marked as "at work" less than 50 percent of the time (Drudi, 1997). For the majority, additional source data were required to verify whether fatalities were work-related. CFOI draws information on fatal work injuries from as many as 25 different sources, including: death certificates, State workers' compensation reports, news media accounts, local police departments, emergency medical services, and Federal agencies. Although this research is focused on job-related deaths, it suggests that the cause of death may be misreported for other types of fatalities as well.

Previously, Lawrence et al. (2006) compared state-level NVSS data to state-level BARD estimates for 2002 and found that "these counts were highly correlated and generally quite close" (Lawrence et al., 2006, p.13). In their analysis, they took the highest fatality count from either BARD or NVSS for each State to calculate their totals for 2002 and conclude that adjusting the BARD estimates upwards by 1 percent is appropriate, confirming USCG's then-standard adjustment factor. While our results demonstrate a larger difference between NVSS and BARD data than the earlier Lawrence et al. (2006) review, our conclusion is similar. Consideration of the procedures used to collect NVSS and BARD data suggests that the BARD data are more reliable and utilizing NVSS alone leads to substantially lower estimates. Extensive efforts have been undertaken by USCG to ensure that all fatalities are captured, and the circumstances surrounding deaths make these types of injuries most likely to be reported (i.e., an investigation by a law enforcement agency likely occurred).

In 2019, Schlotthauer et al. convened a recreational boating injury roundtable and examined the intersection of BARD and national injury datasets (i.e., NVSS). The roundtable workgroup analyzed data from the years 2005 to 2017 using a methodology consistent with the IEc and Robinson (2011) report and found that counts of vessel-related fatalities in BARD were at least 33 percent higher, and at most 69 percent higher, than NVSS estimates during this 13-year period. These national estimates are generally consistent with those found in the NVSS data specific to Florida.

In summary, given review of previous literature and data sources available at the state-level, we conclude that data in BARD reflect the best available accounting of fatalities from recreational boating accidents. As such, no adjustments to these data are necessary.

2.2 NONFATAL INJURIES

2.2.1 METHOD

For nonfatal injuries, we compared data in BARD to data obtained from the HCUP SID and SEDD. Similar to our analysis of fatalities, we began this process by researching all databases suitable for producing state-level estimates of recreational boating injuries (Appendix B). We considered three criteria to determine which databases were suitable to use:

1. Geographic coverage was at the state level and included the state of Florida;
2. Data included codes identifying "boating" as the cause of injury or death;
3. The severity of the injuries was addressed, or the data included descriptions of injuries by type.

Several databases were samples (as opposed to comprehensive) and/or posed additional analytic challenges. For example, we had to assess the degree of overlap across databases (i.e., because an individual patient may be treated in more than one type of setting), consider the extent to which each sample is likely to provide reliable estimates for boating-related injuries (i.e., because these injuries represent a very small proportion of the sample), and determine whether it is possible to distinguish cases where an injury appears more than once in the database because of multiple visits or other factors. In many cases, the sample sizes were too small, or the database included no boating-related cause of injury coding for the state of Florida.

SID and SEDD are part of a family of HCUP databases and software tools. SID consist of hospital inpatient discharge records compiled from various State data organizations.[15] They are composed of annual, state-specific files that share a common structure and common data elements. SID contain clinical and non-clinical information (e.g., charges) on all patients, regardless of payer, including persons covered by Medicare, Medicaid,

[15] http://www.hcup-us.ahrq.gov/sidoverview.jsp

private insurance, and the uninsured. Together, SID encompass more than 97 percent of all U.S. hospital discharges. SID contain 100 percent of hospitals and patient discharges from State government and private data agencies with statewide inpatient data systems.[16] ICD-10-CM cause-of-injury codes are included for a majority of States – including Florida and Minnesota – after 2015. Prior to 2015, ICD-9-CM codes are included.

SEDD are a set of databases for participating States that capture discharge information on all ED visits that do not result in an admission.[17] SEDD contain the ED encounter abstracts translated into a uniform format to facilitate multi-state comparisons. Like SID, SEDD contain a core set of clinical and non-clinical information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance, and the uninsured. To prevent patient overlap and potential double-counting during analysis, information on any patients initially seen in the ED and then admitted to the hospital is solely included in SID. SEDD contain patient-level discharge abstract data from 42 participating States for 100 percent of discharges from hospital-affiliated EDs that do not result in admissions.[18] ICD-10-CM cause-of-injury codes are included for many States following the 2015 update from ICD-9-CM to ICD-10-CM codes.

For both SID and SEDD, ICD-10-CM includes the same set of ICD-10-CM codes as the NVSS. For the full list of vessel-related cause codes, see section 2.1.2. Cause of injury or external cause coding (e.g., determining the appropriate V90-V94 code) is performed by staff trained in medical billing and inclusion of these codes is required for all data reported to State agencies in both Florida and Minnesota.[19, 20]

[16] SEDD capture information on ED visits that do not result in an admission. SID contain information on patients initially seen in the ED and then admitted to the same hospital.

[17] http://www.hcup-us.ahrq.gov/seddoverview.jsp

[18] Neither SID nor SEDD include data from any federal facilities (e.g., US Veterans Affairs hospitals); SEDD does not include data from any standalone emergency rooms (Personal Communication, Adrienne Henderson, Florida Agency for Health Care Administration, January 13, 2022).

[19] Personal Communication, Katherine McDaniel, Florida Department of Health, January 4, 2022; and, Adrienne Henderson, Florida Agency for Health Care Administration, January 13, 2022.

[20] Personal Communication, Jaclyn Roland, David Haverberg, and Molly Yang, Minnesota Hospital Association, and Anna Gaichas, Minnesota Department of Health, September 30, 2022.

2.2.2 DATA AND ANALYSIS

We completed several preliminary data processing steps in preparation for comparing HCUP to BARD data. First, we restricted the SID and SEDD databases to injuries with ICD-10-CM codes beginning with V90, V91, V92, V93, or V94. In years prior to 2015, we only included injuries associated with ICD-9 codes E830-E838, and E910.[21] Second, we removed the injury observations from both the BARD and HCUP data that resulted in fatalities. Third, because the ICD-10-CM codes contain subcategories that reflect the type of vessel (e.g., sailboat, canoe or kayak, water-skis, merchant ship, passenger ship), we separated commercial from recreational boating incidents. Specifically, we removed any incidents occurring on fishing, ferry, or merchant vessels. For 2014, the ICD-9-CM external cause of injury codes do not include subcategories reflecting the type of vessel, and we are not able to separate commercial from recreational boating incidents, which could impart an upward bias in estimated underreporting for that year.

To facilitate comparisons, we primarily relied on treatment location to construct a crosswalk between the HCUP and BARD datasets. For each year, we used a three-tiered method to assign BARD injury data to either SID or SEDD for comparison. The first tier assigned treatment location based on fields in the BARD datasets that indicated whether an injured individual received treatment beyond first aid and/or whether the individual was admitted to a hospital. Exhibit 2-2 illustrates the assignment protocol based on the two relevant BARD fields. For example, if the "treatment beyond first aid" column was populated with "yes" and the "admitted to hospital" column was populated with "no," we categorized that injury as ED and ultimately compared the injury to SEDD.

EXHIBIT 2-2. BARD TREATMENT LOCATION ASSIGNMENT

TREATMENT BEYOND FIRST AID	ADMITTED TO HOSPITAL	FINAL ASSIGNMENT
Yes	No	Emergency Department (compare to HCUP-SEDD)
Yes	Yes	Inpatient (compare to HCUP-SID)
Yes	Not specified	Categorize using Tier 2
Not specified	Not specified	Categorize using Tier 3

[21] In October 2015, the United States transitioned from the ICD-9-CM diagnosis coding system to the ICD-10-CM coding system for most inpatient and outpatient medical encounters and the ICD-10-PCS procedure coding system for inpatient hospital procedures.

If treatment location fields were not populated (i.e., "not specified") in the BARD data for certain injury observations, we moved to Tier 2. In the second tier, we analyzed narratives in BARD describing each accident. The "redacted narrative" BARD data column includes a verbal description of the accident less any private information. Within each narrative, we searched for key words related to treatment location. For example, if a narrative included terms such as "emergency room" or "emergency department," the injury observation was compared to SEDD. If the narrative included terms such as "hospitalized" or "hospital," the injury observation was marked as "inpatient" and compared to SID. While this coding scheme entails some degree of subjectivity, any incorrect assignment will have a negligible effect on results as nearly 99 percent of all BARD injuries in Florida are categorized in Tier 1.

Finally, if treatment location could not be assigned based on tiers 1 or 2, we moved to Tier 3, where we assigned each injury a severity code based on the Abbreviated Injury Scale (AIS) consistent with the method outlined in IEc and Robinson (2011). In short, the AIS severity scale is an injury severity scoring system that classifies each injury by body region on a 5-point scale (i.e., minor, moderate, serious, severe, and critical). We rely on a crosswalk of the BARD categories developed by USCG staff for use in recent regulatory analyses to match the injuries reported in BARD to the AIS categories. As an intermediate step, USCG staff rely on categories used in the Marine Information for Safety and Law Enforcement (MISLE) system, which provide the necessary bridge between boating injuries and the AIS scale. In Exhibit 2-3, the first two columns provide the AIS categories and descriptors, the third and fourth columns provide information from MISLE, and the fifth column provides the BARD injuries assigned by USCG staff to each category.

We used this crosswalk to assign AIS severity codes based on injury type data included in BARD and then made assumptions about the treatment location by code.[22] Because AIS 1 includes less severe injures (e.g., minor scrapes and lacerations), those were categorized as not requiring treatment beyond first aid. AIS 2 includes moderate injuries typically treated in an ED (e.g., broken fingers) and therefore we categorized these injuries as "emergency department." Finally, AIS 3-5 are categorized as "inpatient (admitted to hospital)" due to the more severe nature of these injuries.

[22] IEc conducted a manual review of a sub-set of accident narratives in BARD for injuries that advanced to Tier 3, testing the reliability of the crosswalk accurately categorizing injuries by severity based on the injury type field in BARD. We determined that the crosswalk does not reliably categorize injuries by severity. For example, one accident featured an injury where a 6-inch gash revealed the skull of the victim, who subsequently lost consciousness. This injury was classified as a "cut" in BARD. The crosswalk suggests an injury classified as "cut" is equivalent to an AIS severity level of 1, or a minor injury. In this case, the accident narrative suggested a more severe injury. Based on IEc's analysis of the reliability of the crosswalk, we acknowledge a potential limitation of Tier 3 of this analysis.

EXHIBIT 2-3. CROSSWALK OF NONFATAL INJURY CATEGORIES BY SEVERITY (TIER 3)

AIS LEVEL	CATEGORY/ DESCRIPTION	MISLE DESCRIPTION	MISLE EXAMPLES	BARD INJURY CATEGORIES
1	Minor	The injury is minor or superficial. No professional medical treatment was required.	Minor/superficial scrapes (abrasions); minor bruises; minor cuts; digit sprain; first degree burns; minor head trauma with headache or dizziness; minor sprain/strain.	Scrape/bruise Sprain/strain Cut
2	Moderate	The injury exceeds the minor level but did not result in broken bones (other than fingers, toes or nose), loss of limbs, severe hemorrhaging, muscle, nerve, tendon or internal organ damage. Professional medical treatment may have been required. If so, the person was not hospitalized for more than 48 hours within 5 days of injury.	Broken fingers, toes or nose; amputated fingers or toes; degloving of fingers or toes; dislocated joint; severe sprain/strain; second- or third-degree burns covering 10% or less of body; herniated disc.	Burns Carbon Monoxide Dislocation Hypothermia
3	Serious	The injury exceeds the moderate level and requires significant medical/surgical management. The person was not hospitalized for more than 48 hours within 5 days of the injury.	Broken bones other than fingers, toes or nose; partial loss of limb; degloving of entire hand/arm or foot/leg; second- or third-degree burns covering 20-30% of body; bruised organs.	Broken/fractured Bones Concussion/brain injury
4	Severe	The injury exceeds the moderate level and requires significant medical/surgical management. The person was hospitalized for more than 48 hours of the injury and, if was in intensive care, was in for less than 48 hours.	Internal hemorrhage; punctured organs, severed blood vessels; second/third degree burns covering 30-40% of body; loss of entire limb.	Internal organ injury Shock Amputation
5	Critical	The injury exceeds the moderate level and requires significant medical/surgical management. The person was hospitalized and in intensive care for more than 48 hours within 5 days of injury.	Spinal cord injury; extensive second- or third-degree burns; concussion with several neurological signs; severe crushing injury; second/third degree burns covering over 40% or more of body; severe/ multiple organ damage.	Spinal cord injury

Source: Provided by Office of Standards Evaluation and Development, U.S. Coast Guard, February 17, 2011. BARD Injury Category names updated for this report based on information provided via email by Susan Weber, USCG CG-BSX-2, May 13, 2022.

Injuries that could not be assigned a treatment location based on the tiered process were dropped from the analysis. These represented only 10 observations out of 1,832 total in BARD data from accidents occurring in Florida. Of the 1,822 BARD observations from Florida that were included in the analysis, 1,458 were classified as "inpatient," and 364 were classified as "emergency department." See Exhibits 2-4 and 2-5 for a breakdown by years of both BARD and HCUP data for Florida.

EXHIBIT 2-4. NUMBER OF BOATING-RELATED INJURIES IN FLORIDA, ADMITTED TO HOSPITAL

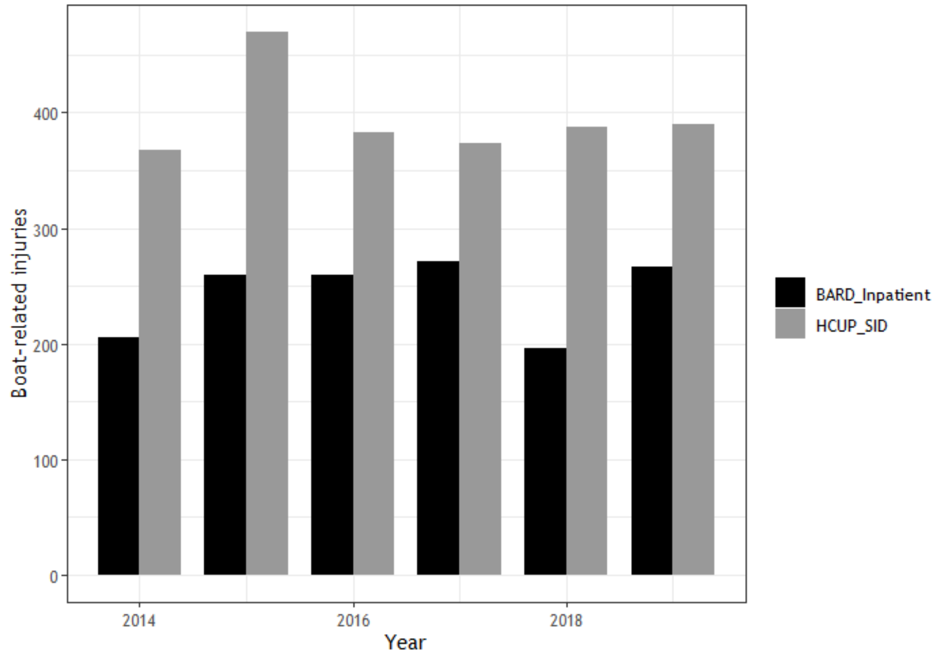
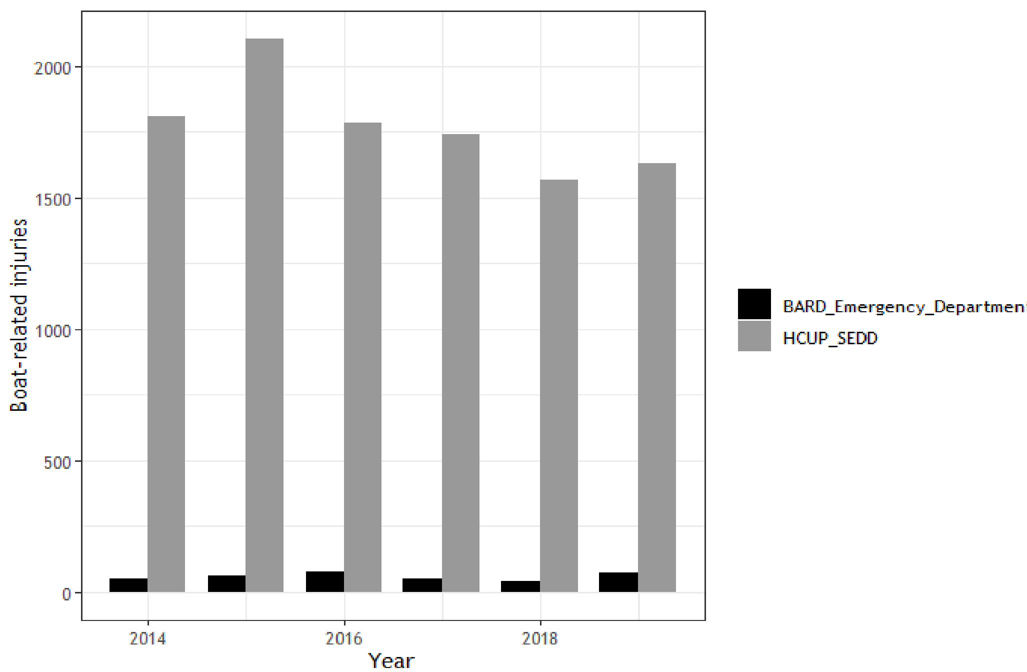


EXHIBIT 2-5. NUMBER OF BOATING-RELATED INJURIES IN FLORIDA, EMERGENCY DEPARTMENT



2.2.3 RESULTS

We compared the BARD coded "emergency department" and "inpatient (hospitalized)" injuries in Florida to the SEDD and SID databases, respectively. Exhibit 2-6 summarizes the implied multipliers based on these annual comparisons. Over the years 2014 through 2019, injuries severe enough to result in hospitalization were underreported in Florida by a factor of approximately 1.4 to 2, with an average of 1.7. Underreporting of injuries in Florida resulting in ED treatment ranged from a factor of 22 to 37, with an average of 30. These results follow intuition and results of prior studies suggesting that underreporting of incidents increases as severity decreases.

EXHIBIT 2-6. NONFATAL INJURY MULTIPLIERS SPECIFIC TO FLORIDA

YEAR	EMERGENCY DEPARTMENT	ADMITTED TO HOSPITAL
2014	34.8	1.80
2015	33.4	1.81
2016	22.6	1.47
2017	32.9	1.38
2018	36.5	1.98
2019	22.0	1.46
Average	30.4	1.65
Note: Averages may not calculate due to rounding.		

These results are comparable to those from IEc and Robinson (2011) for injuries resulting in hospitalization, which reported multipliers ranging from 1.5 to 1.7. Similarly, IEc and Robinson (2011) compared all non-admitted injuries requiring treatment beyond first aid to ED visits and found a multiplier of 31 (years 2005 to 2008, see p. 2-22), which is similar to our average ED multiplier for Florida of 30.37. IEc and Robinson (2011) also estimate a more comprehensive multiplier for nonfatal, non-hospitalized injuries of approximately 120. This larger multiplier considers additional information and data from the National Ambulatory Medical Care Survey (NAMCS). This CDC survey collects information describing visits to office-based physicians and captures those injuries that are not severe enough to treat in an ED. NAMCS is a national dataset that does not distinguish the location or state in which treatment took place, so we were not able to utilize NAMCS data on doctor's office visits for this Florida analysis. As such, our underreporting multiplier of 30.37 for nonfatal, non-admitted injuries in Florida, which only considers ED visits, likely understates the true extent of relevant injuries not requiring inpatient care.

Our results for Florida are also similar in magnitude to Lawrence et al.'s (2006, p.16) implied multiplier of 1.25 for hospital admissions. Finally, Schlotthauer et al. (2019) found that HCUP ED visits *and* hospitalizations exceeded those reported in BARD by a factor of 5 to 7 between 2005 and 2016. By following a similar methodology and combining our hospitalizations and ED discharge counts to determine a single number to represent injuries for each data year, our average multiplier for Florida would be 16.01, with a range of 11.74 to 19.25. Note that we do not recommend using this "combined multiplier" of 16.01; it is provided purely for comparison purposes and does not capture the underlying variation in underreporting between non-admitted injuries and hospitalizations needed for regulatory analysis.[23]

Finally, it is important to note that all three studies referenced above were national in scope, and thus given the variability in state reporting discussed in Chapter 1, differences in national and state-level multipliers are expected.

2.2.4 REPLICATION IN MINNESOTA

As part of this effort, we attempted to recreate the above analysis for Minnesota using BARD and HCUP data. However, for Minnesota, only 6 percent of nonfatal injuries that occurred from 2014 to 2019 are categorized in Tier 1. The remaining 94 percent of nonfatal injuries lack of data on treatment location in BARD (i.e., whether the injury required hospitalization).[24] Given the inability to categorize the majority of injuries in Tier 1, and the subjective nature of the approaches used in Tiers 2 and 3, we were not able confidently to recreate the analysis of underreporting of nonfatal injuries in Minnesota. Future attempts to replicate this analysis in other states also will require data on treatment location in the BARD dataset, which is not a required data field in BARD but is essential to this analytic approach.

[23] The value per avoided injury, applied in regulatory analysis, varies by several orders of magnitude depending on injury severity. Thus, greater differentiation by injury severity is preferred.

[24] For comparison, the Florida BARD specified the treatment location for 99 percent of injuries (see Section 2.2.2).

CHAPTER 3 | PROPERTY DAMAGE

This chapter describes the results of analyses undertaken to investigate potential underreporting of property damage in BARD. We compare property damage estimates in BARD to claim payments from Insurance Company "X" in Florida and Minnesota over a 4-year period for a subset of accidents appearing in both data sources. We also account for claim payments from Insurance Company "X" that were eligible for reporting but are not included in BARD.

3.1 METHOD

The method employed to estimate underreporting of property damage is conceptually related to that for fatalities and injuries described in Chapter 2. We compare the total dollar amount of damage for accidents reported in BARD to relevant Insurance Company "X" claims on an annual basis. Relevant insurance claims include those for accidents reported in BARD, as well as those that were eligible for reporting because damages total at least $2,000, but do not appear in BARD.[25] In this manner, the resultant multiplier reflects variation in BARD damage estimates versus paid insurance claims, as well as damage associated with unreported accidents.

3.2 DATA

USCG provided IEc with accident data in 2015 through 2018 for Florida and Minnesota. The data were obtained from two key sources.

- **BARD:** Data on accidents submitted by State reporting authorities are recorded in BARD (see discussion in Chapter 1). Specifically, property damage estimates focus on damage to vessels and non-vessel property, but do not include the costs of services addressing fuel spills, environmental cleanup, and wreckage removal.[26]
- **Insurance claims data:** Insurance Company "X" contacted CG-BSX-2 in May 2018 citing a concern about underreporting of recreational boating accidents in BARD and agreed to provide claims data to facilitate comparisons. Generally, the company fulfills property damage claims under two different coverages, depending on the type of loss. *Comprehensive claim* payments reflect the amount paid for damage (other than from a collision) to an insured vessel, less

[25] BARD's reportability requirements are outlined in Chapter 1. We note that accidents resulting in damage totaling less than $2,000 may be reportable to BARD for other reasons (e.g., an injury requiring more than first aid, or a fatality occurred).

[26] Personal Communication, Susan Weber, CG-BSX-21, April 6, 2022.

deductibles, for policyholders with comprehensive coverage.[27,28] *Property claims* reflect payments for a combination of damage to the insured vessel caused by a collision, damage to another vessel that Insurance Company "X" is liable for, other non-vessel property damaged caused by an accident (e.g., damage to docks, lifts, other vessels, etc.), and any needed services to address fuel spills, environmental cleanup, and wreckage removal.[29]

USCG staff performed initial cleaning and analysis of the insurer's dataset, including identifying insurance claims records associated with accidents in BARD (matched insurance claims), identifying insurance claims records associated with accidents that met BARD's reporting requirements (i.e., damage ≥ $2,000) but were not present in BARD (eligible non-matched insurance claims), and removing invalid entries (USCG 2021). This ultimately resulted in matched claims for 271 accidents in Florida and 36 accidents in Minnesota, and non-matched claims for an additional 2,890 eligible accidents in Florida and 724 eligible accidents in Minnesota.

Upon receipt of the datasets, IEc conducted several additional steps to prepare the data for analysis.

1. We identified BARD property damage estimates for *all* of the vessels involved in each accident where at least one vessel matched an insurance claim. Specifically, USCG previously matched only the individual vessels insured by Insurance Company "X" with the property damage for those specific vessels in BARD. If a second vessel was involved in an accident, the dollar value of damage reported in BARD for the second vessel was previously matched by USCG to the insurance claim only if the second vessel was present in the claims dataset. In cases where the Insurance Company "X"-insured boater was liable for the accident, the value of the damages to the second vessel would be included in the insurance property claims data for that accident.[30] However, if the second vessel was not insured by Insurance Company "X", USCG would not have matched the BARD data for that vessel to the claims dataset. Therefore, to avoid an upwards bias in our multiplier (i.e., avoid overstating underreporting in BARD), the value of damage to the second vessel should be included for comparison purposes. Linking the value of damages in BARD for the second vessel to the insurance data was accomplished through a manual review of BARD data from the vessel-level datasets.
2. We then removed BARD damage estimates for non-Insurance Company "X"-insured vessels if the Insurance Company "X"-insured vessel involved in the accident was not at fault. Removing BARD damage estimates for these vessels avoids downward bias on the resulting multiplier (i.e., avoids understating the

[27] Personal Communication, Insurance Company "X", April 6 and December 6, 2022.

[28] According to Insurance Company "X", "comprehensive covers events out of your [the insured party's] control, such as theft, vandalism, sunken boat, fires, heavy winds, hurricanes, and other weather-related damage."

[29] Personal Communication, Insurance Company "X", December 6, 2022.

[30] Ibid.

multiplier), because in these cases, we would not expect the damages for the non-Insurance Company "X"-insured vessel to be included in the insurance claims dataset. We conducted a manual review using the VesselCause1 field in the BARD data, matching vessels to the insurance claims dataset using the BARD ID and Vessel ID fields.

3.3 ANALYSIS

In this section, we describe our analysis of the datasets described in Section 3.2. First, we compare total damage values for the matched accidents appearing in both the BARD and the insurer's datasets. Then, we report the total damages for accidents in the insurer's dataset that were eligible for reporting but are not found in the BARD dataset. We combine the information from these two steps to estimate the underreporting multipliers presented in Section 3.4.

3.3.1 MATCHED INSURANCE CLAIMS

USCG staff identified Insurance Company "X" claims for 271 accidents in Florida and 36 accidents in Minnesota between 2015 and 2018 that are reported to BARD.[31] The initial step of the analysis involves calculating annual property damage totals for the matched claims in the BARD and the insurer's datasets. For the BARD total, we simply sum the damage estimates in each year using the final dataset described above in Section 3.2.

For the Insurance Company "X" data, first we calculate the total damage per accident by summing the property and comprehensive payments for each unique matched claim in the final dataset (see Section 3.2). In addition, to account for policy deductibles, we added an average value of $447 and $225 to each claim in Florida and Minnesota, respectively.[32] Then, we sum the total for each individual claim in each year to find the annual total damage payments by Insurance Company "X" for accidents also identified in BARD.

Exhibit 3-1 presents the annual property damage totals for the matched insurance claims in Florida and Minnesota. As shown, BARD reported annual damages from recreational boating ranging from approximately $700,000 to $1.1 million in Florida, and approximately $22,000 to $100,000 in Minnesota. Over the 4-year period, BARD reports total property damage from recreational boating accidents totaling nearly $3.5 million in Florida and nearly $190,000 in Minnesota. During the same time period, Insurance Company "X" paid nearly $5.0 million (inclusive of estimated deductibles) in matched claims in Florida and just over $310,000 in matched claims in Minnesota during the same time period. In a given year, Insurance Company "X" total claim payments exceeded matched BARD damage estimates by a factor of 1.1 to 1.9 in Florida and 1.1 to 2.4 in Minnesota.

[31] USCG staff initially identified 274 accidents as having been captured both by BARD and Insurance Company "X" in Florida. Two of the records did not have publicly releasable data, and one was a duplicate of another record that was already in the dataset.

[32] These represent average deductibles paid by Florida and Minnesota policy holders. (Personal Communication, Insurance Company "X", April 12, 2022.)

EXHIBIT 3-1. SUMMARY OF MATCHED INSURANCE COMPANY "X" CLAIMS DATA

	BARD	INSURANCE COMPANY "X"			
YEAR	PROPERTY DAMAGE	PROPERTY DAMAGE PAYMENTS (a)	COMPREHENSIVE DAMAGE PAYMENTS (b)	TOTAL DEDUCTIBLE PAID (c)	TOTAL CLAIM PAYMENTS (d = a+b+c)
Florida					
2015	$696,454	$599,093	$450,583	$32,631	$1,082,307
2016	$1,113,659	$867,289	$328,950	$29,949	$1,226,188
2017	$949,350	$852,684	$433,326	$31,290	$1,317,300
2018	$730,072	$941,266	$391,469	$27,267	$1,360,002
Total	**$3,489,535**	**$3,260,332**	**$1,604,329**	**$121,137**	**$4,985,798**
Minnesota					
2015	$99,877	$119,507	$3,779	$2,025	$125,311
2016	$24,825	$55,068	$0	$2,925	$57,993
2017	$43,400	$100,582	$0	$2,250	$102,832
2018	$22,000	$5,347	$17,782	$900	$24,029
Total	**$190,102**	**$280,504**	**$21,561**	**$8,100**	**$310,165**
Source: BARD and Insurance Company "X" data (provided to IEc by USCG via electronic file transfer on September 13, 2021).					

3.3.2 ELIGIBLE NON-MATCHED INSURANCE CLAIMS

Eligible non-matched Insurance Company "X" claims are insurance claims from accidents that meet BARD's reportability requirements because they total at least $2,000 but are not captured in BARD. We calculate annual property damage totals for the eligible non-matched insurance claims using the same method employed to analyze matched claims; we sum the insurer's data on comprehensive payments, property payments, and estimated deductibles. Exhibit 3-2 presents these totals.

As shown, Insurance Company "X" paid approximately $20 million (inclusive of deductibles) in claims in Florida and approximately $3.8 million in claims in Minnesota from 2015 through 2018 for accidents that were eligible for inclusion but not recorded in BARD. Annually, non-matched claims totaled approximately $4.4 million to $5.7 million in Florida and $830,000 to $1.0 million in Minnesota.

EXHIBIT 3-2. SUMMARY OF ELIGIBLE NON-MATCHED INSURANCE COMPANY "X" CLAIMS DATA

YEAR	INSURANCE COMPANY "X" PROPERTY DAMAGE PAYMENTS (a)	COMPREHENSIVE DAMAGE PAYMENTS (b)	TOTAL DEDUCTIBLE PAID (c)	TOTAL CLAIM PAYMENTS (d = a+b+c)
Florida				
2015	$3,672,867	$444,011	$299,937	$4,416,815
2016	$4,563,296	$476,169	$345,978	$5,385,443
2017	$4,103,867	$426,655	$297,702	$4,828,224
2018	$5,053,916	$336,301	$348,213	$5,738,430
Total	**$17,393,946**	**$1,683,135**	**$1,291,830**	**$20,368,911**
Minnesota				
2015	$924,912	$55,819	$43,650	$1,024,381
2016	$842,980	$67,116	$44,100	$954,196
2017	$783,684	$9,949	$34,875	$828,508
2018	$961,910	$19,834	$40,275	$1,022,019
Total	**$3,513,486**	**$152,718**	**$162,900**	**$3,829,104**

Source: Insurance Company "X" data.

3.4 RESULTS

3.4.1 DOLLAR-BASED UNDERREPORTING MULTIPLIER

Based on this analysis of the available insurance data we find that BARD data understates property damage. This is principally due to underreporting of eligible accidents and, to a lesser extent, lower recorded property damage estimates relative to paid insurance claims. Exhibit 3-3 presents the annual multipliers comparing total paid claims in the insurance data for all eligible accidents (both reported and non-reported) to total damage estimates contained in BARD, for both Florida and Minnesota.

The BARD underreporting multipliers for each year are calculated as the sum of a year's matched insurance claims and eligible non-matched insurance claims divided by the year's total BARD property damage estimate for matched accidents. The summary multiplier for each state is calculated in the same way, as the sum of total matched insurance claims and total eligible non-matched insurance claims divided by the total BARD property damage estimate for matched accidents between 2015 and 2018 (i.e., we pool the data for 2015 through 2018 to estimate the summary multiplier).

EXHIBIT 3-3. PROPERTY DAMAGE UNDERREPORTING MULTIPLIERS

YEAR	PROPERTY DAMAGE FOR MATCHED CLAIMS (BARD) (a)	PROPERTY DAMAGE (ALL ELIGIBLE INSURANCE COMPANY "X" CLAIMS) (b)	BARD UNDERREPORTING MULTIPLIER (c = b/a)
Florida			
2015	$696,454	$5,499,123	7.90
2016	$1,113,659	$6,611,631	5.94
2017	$949,350	$6,145,524	6.47
2018	$730,072	$7,098,431	9.72
Total	**$3,489,535**	**$25,354,709**	**7.27**
Minnesota			
2015	$99,877	$1,149,692	11.51
2016	$24,825	$1,012,189	40.77
2017	$43,400	$931,340	21.46
2018	$22,000	$1,046,048	47.55
Total	**$190,102**	**$4,139,269**	**21.77**
Source: IEc analysis of information provided in Exhibits 3-1 and 3-2.			

The summary multiplier across the timeframe of the insurance claims dataset suggests that for every dollar in property damage that BARD recorded in Florida, $7.27 in property damage was incurred. The data also suggest that for every dollar in property damage that BARD recorded in Minnesota, $21.77 in property damage was incurred. Note that applying these multipliers to all BARD data assumes that the reporting behaviors observed in the Insurance Company "X" data are representative of the recreational boating population in Florida and Minnesota at large.[33] We do not have any *a priori* reasons to believe that claims adjustment practice or accident reporting rates are likely to differ based on insurance carrier (and therefore result in a significantly different value if all other carriers/vessels were included in the analysis).

3.4.2 INFLUENCE OF UNREPORTED ACCIDENTS

The scale of total paid Insurance Company "X" claims for eligible non-matched accidents in Florida (approximately $20 million, see Exhibit 3-2) compared to the difference in matched insurance claims and property damage records in BARD for Florida (approximately $1.5 million, see Exhibit 3-1) indicates that the dollar-denominated underreporting multiplier for Florida is driven by damage associated with unreported accidents. Data from Minnesota lead to the same conclusion, where the scale of total paid Insurance Company "X" claims for eligible non-matched accidents (approximately $3.8

[33] In the rare instance of a Florida-specific rulemaking or analysis, USCG could consider using the Florida-specific multipliers presented in this report in its main analysis (instead of the multipliers from IEc and Robinson (2011)) or in sensitivity analysis.

million) dwarfs the difference in matched insurance claims and property damage records in BARD (approximately $120,000).

This is also apparent when examining the *number* of accidents in the matched insurance claims relative to the eligible non-matched insurance claims for both Florida and Minnesota. In Florida, only between 1 in 10 to 1 in 14 eligible accidents were recorded in BARD in the years 2015 to 2018, or an overall average of 1 in 12. In Minnesota, between 1 in 16 and 1 in 46 eligible accidents were recorded in BARD in the years 2015 to 2018, or an overall average of 1 in 21. Exhibit 3-4 presents a summary detailing the influence of unreported accidents. These results suggest that for every accident with property damage occurring in Florida, approximately 11 go unreported. Similarly, for every accident with property damage occurring in Minnesota, approximately 20 go unreported.

EXHIBIT 3-4. SUMMARY OF ANALYSIS OF UNREPORTED ACCIDENTS

YEAR	# OF ACCIDENTS (MATCHED INSURANCE COMPANY "X" CLAIMS)	# OF ACCIDENTS (NON-MATCHED INSURANCE COMPANY "X" CLAIMS)	IMPLIED RATIO OF REPORTED ACCIDENTS
Florida			
2015	73	671	~ 1/10
2016	67	774	~ 1/13
2017	70	666	~ 1/11
2018	61	779	~ 1/14
Total	**271**	**2,890**	**~ 1/12**
Minnesota			
2015	9	194	~ 2/45
2016	13	196	~ 1/16
2017	10	155	~ 2/33
2018	4	179	~ 1/46
Total	**36**	**724**	**~ 1/21**

CHAPTER 4 | USE OF MULTIPLIERS IN USCG ANALYSIS

In the previous chapters, we reviewed data on the number of fatal and nonfatal recreational boating injuries and the value of related property damage estimates in BARD in relation to relevant external data sources. This information suggests that adjustments should be made to BARD data to capture the true consequences of recreational boating accidents. In this chapter, we demonstrate how USCG analysts can apply our findings using an illustrative case study.

We begin by proposing a series of underreporting multipliers, based on past and current analyses, for use in future analyses. Next, we present DHS's recommended approach for valuing avoided fatalities and nonfatal injuries. We illustrate the application of these multipliers and monetary values in a stylized example of a proposed rule intended to reduce the risk of recreational boating accidents. Our conclusions and recommendations for additional research are provided at the end of the chapter.

4.1 RECOMMENDED BARD MULTIPLIERS FOR USCG ANALYSES

For future regulatory analysis, we recommend using a combination of the new multipliers presented in this report and previous estimates from IEc and Robinson (2011), as follows:

- ***Fatalities:*** IEc and Robinson (2011) as well as the updated Florida-specific analysis presented in this report suggest that BARD represents the best source of information about fatalities resulting from recreational boating accidents. Therefore, we recommend that fatalities in BARD receive no adjustment for use in regulatory or other analysis.
- ***Nonfatal injuries:*** IEc and Robinson (2011) remains the best available nationwide estimates of nonfatal injury underreporting in BARD. The Florida-specific analysis presented in this report provides reassuring evidence that the 2011 estimates continue to be reasonable.[34]
- ***Property damage:*** The multipliers from Florida and Minnesota presented in this report represent the only attempt to understand how property damage may be underestimated in BARD. While two states do not constitute a nationally representative sample, the reporting behaviors and scale of property damage from recreational boating accidents in Florida and Minnesota reflect a range of behaviors that may be observed nationwide. We recommend applying the Florida

[34] In the rare instance of a Florida-specific rulemaking or analysis, USCG could consider using the Florida-specific multipliers presented in this report in its main analysis (instead of the multipliers from IEc and Robinson (2011)) or in sensitivity analysis.

and Minnesota property damage multipliers as a range in future analysis. Future efforts may seek to incorporate other States into this analysis.

Exhibit 4-1 summarizes the multipliers we recommend adopting for future use.

EXHIBIT 4-1. SUMMARY OF BARD MULTIPLIERS AND RECOMMENDATIONS FOR USE IN ANALYSIS

DAMAGE CATEGORY	IEC AND ROBINSON (2011)	FLORIDA ANALYSIS	MINNESOTA ANALYSIS	RECOMMENDED MULTIPLIER FOR USCG'S USE IN REGULATORY ANALYSIS
Fatalities	1	1	N/A	**1**
Injuries				
Minor	120	N/A	N/A	**120**
Moderate	1.5 – 120*	30.4*	N/A	**1.5 - 120**
Serious	1.5 – 1.7	1.65	N/A	**1.5 - 1.7**
Severe	1.5 – 1.7	1.65	N/A	**1.5 - 1.7**
Critical	1.5 – 1.7	1.65	N/A	**1.5 - 1.7**
Property Damage	N/A	7.27	21.77	**7.27 - 21.77**

Sources: IEc and Robinson (2011) and IEc analysis using data sources presented in this report. Cells marked "N/A" denote instances where analysis was not conducted due to data limitations or analytic decisions.

Note:

* Our analysis assumes that any nonfatal injuries not resulting in hospitalization were treated in an emergency department setting and compares injury counts in BARD to emergency department visits in HCUP. However, some injuries identified in BARD as "moderate" may have been treated in other settings (e.g., doctor's offices). Thus, this multiplier is likely understated.

IEc and Robinson (2011) were able to identify a national data source that allowed them to compare all non-admitted injuries requiring treatment beyond first aid to a more expansive dataset including doctor's office visits. This comparison resulted in a multiplier of 120.

4.2 VALUING AVOIDED FATALITIES AND NONFATAL INJURIES

The approach used to value risk reductions in Federal regulatory analyses is determined, at least in part, by guidance issued by OMB to implement Executive Order 12866, as supplemented by Executive Order 13563 (Clinton 1993; Obama 2011). This guidance is contained in OMB's Circular A-4 (2003). The DHS Chief Regulatory Economist provides additional clarification regarding the values to be used in regulatory analyses by component agencies. These values are described in greater detail below.

4.2.1 AVOIDED FATALITIES

To value mortality risk reductions (i.e., avoided fatalities), Federal agencies rely on estimates of individual WTP for small changes in risk, conventionally converted into

VSL estimates. The starting point is an estimate of individual WTP for a small risk reduction in a particular time period; e.g., for a one-in-ten-thousand change in the chance of dying in the current year. This WTP is then divided by the risk change to estimate the individual's VSL. Alternatively, this WTP can be multiplied by a population risk change to determine the value of a community-wide risk reduction.

For example, if an individual is willing to pay $900 for a 1 in 10,000 reduction in his or her risk of dying in the current year, then his or her VSL is calculated as:

$900 individual WTP ÷ 1/10,000 annual risk change

= $9.0 million VSL

Alternatively, if $900 is the average WTP for this risk reduction across all affected individuals, and the number of affected individuals is 10,000, then aggregating these values leads to the same VSL:

$900 average individual WTP x 10,000 affected individuals annually

= $9.0 million VSL

VSL is not the value of an individual's life; it is simply the conventional way to express the value of small risk reductions.

OMB allows agencies some discretion in determining which VSL estimate best fits their regulations. Within DHS, the Chief Regulatory Economist issues annual guidance on the VSL to be used by component agencies, including USCG, in regulatory analyses. Specifically, as of April 5, 2021, agencies are directed to use a VSL of $11.6 million (2020 dollars) (Houser and Sunstein 2021). This value is based on guidance issued by the U.S. Department of Transportation (DOT 2021).[35]

4.2.2 AVOIDED NONFATAL INJURIES

The approaches used by Federal agencies to value nonfatal risk reductions (e.g., avoided nonfatal injuries) are more diverse than the approaches used to value fatality risks. While OMB (2003) recommends that agencies apply estimates of individual WTP, such estimates are lacking for many of the nonfatal risks of concern in Federal policy and regulatory analysis, and agencies differ in the approaches they use as proxies. In particular, WTP estimates for the types of injuries resulting from boating accidents are generally not readily available.

The USCG maintains a "best practices" document (USCG 2020b) that is regularly updated based on feedback from the DHS Chief Regulatory Economist and OMB on the preparation of regulatory analyses. In that document, USCG refers staff to DOT (2021), which includes guidance on values for avoided nonfatal injuries. We understand that although USCG's best practices document does not specifically address the valuation of

[35] The DOT guidance reflects the results of a review of the VSL literature conducted in 2013. DOT adjusts the resulting value each year for inflation and changes in real income (DOT 2021).

nonfatal injuries, in practice, it has applied the DOT approach in past analyses, and those analyses have been cleared by DHS.

The DOT-wide guidance categorizes nonfatal injuries by severity using the AIS, then calculates the monetized quality-adjusted life year (QALY) losses associated with injuries in each AIS category.[36] The AIS is published by the Association for the Advancement of Automotive Medicine (AAAM, 2008) and provides "an anatomically-based, consensus-driven, global severity scoring system that classifies each injury by body region according to its relative importance on a 6-point ordinal scale" (AAAM, 2008, p. 2). The six-point scale is used to categorize injuries from minor to unsurvivable. The placement of injuries on the scale is determined by a group of experts who take into account factors such as the risk of death, the extent of tissue damage, the need for hospitalization, the effect on quality of life, and other issues. If an individual is affected by more than one injury, the Maximum AIS (MAIS) is used in categorizing the set of injuries.

DOT's QALY estimates were originally derived using the Injury Impairment Index, which focuses on changes in functional status over time, based on an approach described in Miller et al. (1991) and Miller et al. (1995). However, the preference weights for different health states that DOT currently uses are based on Spicer and Miller (2010, 2011). DOT estimates the median fraction of a QALY associated with injuries in each AIS category, then multiplies these fractions by its standard VSL estimate to determine the value of averting injuries in each category. For example, if an injury is in an AIS category for which the fraction is five percent, this means that its dollar value is five percent of the value of a life saved and averting 20 such injuries would have the same value as averting one fatality.

Exhibit 4-2 presents the current DOT VSL fractions (or relative disutility factors) for each AIS category. It also presents the monetary value of each MAIS category. These values are calculated by multiplying each fraction by a VSL of $11.6 million (2020 dollars).

[36] QALYs are a non-monetary measure of the effects of injury or illness on the health-related quality of life over time. They allow analysts to combine the impacts of various conditions (e.g., loss of mobility, loss of cognitive function) into a single measure. Originally developed for use in ranking or prioritizing public health problems and analyzing the cost-effectiveness of health policy and medical treatment decisions, QALYs are at times assigned dollar values (e.g., a value per statistical life year or value per QALY) and used for valuation in regulatory benefit-cost analyses.

EXHIBIT 4-2. DOT'S RELATIVE DISUTILITY FACTORS AND VALUES

MAIS CATEGORY	SEVERITY	FRACTION OF VSL	VALUE (2020$)
1	Minor	0.003	$34,800
2	Moderate	0.047	$545,000
3	Serious	0.105	$1,220,000
4	Severe	0.266	$3,090,000
5	Critical	0.593	$6,880,000
Source: DOT (2021) and IEc calculations. Values rounded to three significant digits.			

These unit values can be applied to avoided nonfatal injuries when estimating the likely benefits of proposed regulations. For example, if a proposed regulation is likely to result in the avoidance of 15 serious (MAIS 3) injuries in a single year, the value of those avoided injuries in that year is $18.3 million (15 * $1,220,000 = $18,300,000).

4.3 ILLUSTRATIVE EXAMPLE

In this section, we demonstrate how USCG analysts should apply the multipliers summarized in section 4.1, and the values summarized in section 4.2, to estimate the value of avoided recreational boating accidents in regulatory analyses. We begin by providing a description of a hypothetical rulemaking, including data on likely avoided accidents obtained from BARD. Next, we describe the steps analysts would undertake to adjust the BARD data and estimate the value of incremental risk reduction. Finally, we present our results.

4.3.1 HYPOTHETICAL RULEMAKING

Imagine the USCG is contemplating a proposed rule that would require updated safety equipment on certain types of recreational vessels (e.g., boats of a certain size and length with a specific type of motor). Subject matter experts (SMEs) reviewed multiple years of BARD data and identified all accidents associated with these types of boats. The average annual fatalities, nonfatal injuries, and property damage resulting from these accidents are summarized below in Exhibit 4-3.

EXHIBIT 4-3. AVERAGE ANNUAL INCREMENTAL RISK REDUCTION BASED ON BARD DATA

DAMAGE CATEGORY	BASELINE RISK (a)	LIKELY EFFECTIVENESS OF THE PROPOSED RULE (b)	INCREMENTAL RISK REDUCTION (c = a * b)
Fatalities	2.8	80%	2.2
Injuries			
Minor	18.6		14.9
Moderate	9.8		7.8
Serious	19.6		15.7
Severe	2.5		2.0
Critical	0.5		0.4
Property Damage	$3,500,000		$2,800,000

Source: IEc hypothetical example.
* Assumes analysts assign nonfatal injuries identified in BARD to severity categories using the crosswalk provided in Exhibit 2-3.

The SMEs estimate that 80 percent of these accidents would have been avoided if the new regulation had been in place. Multiplying the damages identified in BARD by 0.80 results in 2.2 avoided fatalities, 14.9 avoided minor injuries, 7.8 avoided moderate injuries, 15.7 avoided serious injuries, 2.0 avoided severe injuries, 0.4 avoided critical injuries, and $2,800,000 in avoided property damage in a given year. In the following sections we demonstrate how to adjust for underreporting of injuries and property damage in BARD and monetize the incremental risk reductions. Note that it is computationally equivalent to adjust the baseline risk estimates by our recommended multipliers and then multiply by 0.8 to calculate the incremental reductions from the rule or apply our recommended multipliers directly to the incremental reductions.

4.3.2 ANALYTIC STEPS

To estimate the value of incremental risk reductions likely to result from the proposed rule, analysts must: (1) adjust the avoided fatal and nonfatal injuries identified in Exhibit 4-3 for underreporting, and (2) multiply the number of avoided fatalities or injuries by a monetary value. We describe the calculations below and summarize the resultant values in Exhibit 4-4.

- **Fatalities.** Our analysis suggests BARD is the best source data on boating fatalities. As a result, estimates of the number of fatalities derived from BARD do not require adjustment. Analysts should multiply the annual number of expected avoided fatalities by the VSL, or $11.6 million in accordance with DHS guidance. In this example, multiply 2.2 avoided fatalities by $11.6 million to find the value of avoided fatalities associated with the proposed rule.

- **Minor Injuries (MAIS 1).** IEc and Robinson (2011) calculated a multiplier of 120 for injuries in this category. We recommend multiplying BARD injuries identified as minor by this amount. Then, multiply the resulting avoided injuries by the DOT value for minor injuries ($34,800).
- **Moderate injuries (MAIS 2).** Adjust the number of avoided injuries by the recommended multiplier for non-hospitalized injuries, as expressed in Exhibit 4-2 (1.5 – 120). The adjustment will be presented as a range. In this case, multiply 7.8 avoided moderate injuries by the range 1.5 – 120 to find the range of possible values of avoided moderate injuries associated with the proposed rule: 11.7 – 936 avoided moderate injuries. The wide range of this multiplier reflects the uncertainty surrounding treatment setting for these injuries (e.g., doctor's office, emergency department, or hospitalization). To value these avoided injuries, multiply the adjusted number of injuries by the DOT value for moderate injuries ($545,000).
- **Serious injuries (MAIS 3).** Adjust the number of avoided injuries by the recommended multiplier for injuries discharged from inpatient treatment (1.5 – 1.7). Then, multiply the adjusted number of injuries by the DOT value for serious injuries ($1,220,000).
- **Severe injuries (MAIS 4).** Adjust the number of avoided injuries by the recommended multiplier for injuries discharged from inpatient treatment (1.5 – 1.7). Then, multiply the adjusted number of injuries by the DOT value for severe injuries ($3,090,000).
- **Critical injuries (MAIS 5).** Adjust the number of avoided injuries by the recommended multiplier for injuries discharged from inpatient treatment (1.5 – 1.7). Then, multiply the adjusted number of injuries by the DOT value for serious injuries ($6,880,000).
- **Property damage.** Finally, analysts should address property damage. Multiply the incremental reduction in property damage by the recommended property damage multiplier (7.27 – 21.77), based on the analysis in Chapter 3.

4.3.3 RESULTS

Exhibit 4-4 summarizes the results of our analysis, showing the intermediate steps used to calculate monetized incremental benefits of the new regulation. The total expected incremental benefits are between approximately $157 million and approximately $707 million.

EXHIBIT 4-4 SUMMARY OF RESULTS

DAMAGE CATEGORY	INCREMENTAL RISK REDUCTION (a)	STEP 1: APPLY MULTIPLIER (b)	STEP 2: MULTIPLY BY VALUE (c)	INCREMENTAL BENEFIT OF RISK REDUCTION (d = a * b * c)
Fatalities	2.2	N/A	$11,600,000	$25,520,000
Injuries				
Minor	14.9	120	$34,800	$62,222,400
Moderate	7.8	1.5 - 120	$545,000	$6,376,500 - $510,120,000
Serious	15.7	1.5 - 1.7	$1,220,000	$28,731,000 - $32,561,800
Severe	2.0	1.5 - 1.7	$3,090,000	$9,270,000 - $10,506,000
Critical	0.4	1.5 - 1.7	$6,880,000	$4,128,000 - $4,678,400
Property Damage	$2,800,000	7.27 – 21.77	N/A	$20,356,000 - $60,956,000
			Total	**$156,603,900 - $706,564,600**

Source: IEc analysis, IEc and Robinson (2011), Houser and Sunstein (2021), and DOT (2021).
Note: To allow analysts to follow our calculations, we present unrounded values in Column D. For regulatory analysis, analysts should round results to 3 or fewer significant digits.

4.4 CONCLUSIONS AND KEY UNCERTAINTIES

Our analysis finds that BARD data underreports injuries and property damage resulting from recreational boating accidents. We developed state-specific multipliers for Florida and Minnesota to capture underreporting of injuries treated in EDs and via inpatient admissions, as well as accidents that involve property damage. We also propose a series of recommended multipliers to capture underreporting of nonfatal injuries and property damage resulting from recreational boating accidents in future analyses. In interpreting the results of the hypothetical rulemaking example presented here, and considering application of these multipliers more broadly, three principal sources of uncertainty should be recognized:

- The multipliers from IEc and Robinson (2011) are more than 10 years old. Changes in reporting requirements or processes (both to BARD and at the state level) in the intervening years may have affected actual underreporting. For example, if more state resources are devoted to investigating and reporting boating accidents, the actual multipliers may be lower. Similarly, if resources for investigations have declined, the multipliers may be overstated. The fact that the Florida-specific nonfatal multipliers calculated for this current effort fall within the ranges of the 2011 report provides reassurance that the multipliers from IEc and Robinson (2011) are still accurate and the best available information for use in national-level analyses.
- The property damage multipliers are based on data from a subset of the Florida and Minnesota recreational boating population obtaining

insurance from Insurance Company "X". We do not have any *a priori* reasons to believe that claims adjustment practice or accident reporting rates are likely to differ based on insurance carrier (and therefore result in a significantly different value if all other carriers/vessels were included in the analysis). We present a recommended multiplier range bound by the Florida and Minnesota property damage multipliers and interpret these relationships to be sufficiently representative to apply to BARD accident data generally.

The stylized example suggests that the multiplier applied to minor and moderate injuries can have a significant impact on benefit estimates. Ideally, USCG would conduct additional research in order to obtain more precise estimates for this injury category. However, the lack of detail available to USCG regarding treatment location for BARD-reported injuries (e.g., hospitalization, treatment in an outpatient setting) is a significant limitation. USCG may need to conduct primary research, through boating surveys or other means, to obtain more precise estimates of minor and moderate injuries.

Recreational Boating Underreporting Multiplier Tool

In coordination with the analysis presented in this report, IEc prepared a Microsoft Excel-based tool to assist CG-REG-1 analysts preparing regulatory analyses. Please contact Evan Morris to access the tool.

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APPENDIX A | ANNOTATED BIBLIOGRAPHY

This appendix summarizes published articles and reports describing: (1) the numbers and types of fatal and nonfatal injuries associated with recreational boating accidents; and/or (2) the monetary value of property damage associated with recreational boating accidents.

To identify these studies, we began by reviewing the abstracts included in IEc and Robinson (2011).[37] We supplemented these studies with new searches using Google Scholar and other online bibliographic databases, as well as with recommendations from USCG staff. In general, our more recent search focused on studies published since 2011.

We include studies cited in the main text of our 2011 report, as well as studies that we reviewed in 2011 but deemed less useful. These latter documents generally focus too narrowly (e.g., on a particular location or accident type) to support an evaluation of state estimates or focus on the effectiveness of particular interventions rather than on baseline incidence. We also include eleven additional studies identified in our more recent searches. From our more recent searches, we find one report that examines the overlap between BARD and national injury datasets (Schlotthauer, 2019), and another that examines the impacts of regulations on recreational boating accidents in Florida (Hsieh, 2020). We also find one study evaluating the accuracy of external cause of injury codes (E codes) in transport injury reporting (Bowman and Aitken, 2011). However, none of these studies provides additional data sources on boating accidents for comparison with BARD.

In the following sections, we provide citations and abstracts for the publications identified in our 2011 and 2021, and 2022 literature searches (see Chapter 2 for discussion). For descriptions of the three major prior studies (SRG 2003, Lawrence et al. 2006, and IEc and Robinson 2011) on this topic conducted by USCG, see Chapter 1. The literature is organized in two sections:

(1) Numbers and type of fatal and nonfatal boating-related injuries; and

(2) Boating-related property damage.

If a study applies to both sections, the full annotation is provided only once, in section A.1.

[37] For a description of the search methodology used in IEc and Robinson (2011), please see that report.

A.I. NUMBERS AND TYPES OF FATAL AND NONFATAL BOATING-RELATED INJURIES

Bowman, S.M. & M.E. Aitken. 2011. Assessing External Cause of Injury Coding Accuracy for Transport Injury Hospitalizations. ***Perspectives in Health Information Management, 8(*****Fall), 1c.**

This study examines the accuracy and completeness of ICD-9-CM external cause of injury codes (E codes) reported in administrative discharge records associated with motor vehicle accidents. The study compares hospital discharge data from the University of Arkansas for Medical Sciences Hospital and the Arkansas Children's Hospital to trauma registry data from each hospital. Trauma registry data are viewed as the gold standard. Approximately 99.9 percent (2,192) of hospital discharge records for patients with E codes of E810.0–E825.9 (motor vehicle crashes) in the years 2006-2008 were accurately linked to trauma registry records. However, exact matches of hospital discharge E codes to trauma registry records were rare – only 39.3 percent of discharge records matched trauma registry records exactly. Overall, the study concludes there is generally good agreement among the E code classification between hospital discharge records and trauma registry records, but investment needs to be made to improve accuracy and detail of E codes.

Emergency Nurses Association, Departments of Research, Practice, and the Injury Prevention Institute/ EN CARE. 2007. ***Recreational Boating Injuries Treated in U.S. Emergency Departments Final Report: 2001 through 2005*****. Prepared for the U.S. Coast Guard.**

This report describes the results of a 4-year data collection effort conducted for the purpose of making recommendations on how to reduce injuries resulting from recreational boating accidents. In 2001, 2002, 2004 and 2005, voluntary questionnaires were offered to patients admitted to each of 75 participating emergency departments throughout the United States. The resulting sample was analyzed to identify correlating factors in boating accidents. The study concluded that operator error was the most prevalent contributing factor to boating accidents that result in injury. Results also indicated that boat safety education decreases the incidence of risky behavior in operators, such as speeding, drinking, and not wearing a personal floatation device (PFD).

Fiore, D.C. & J. D. Houston. 2001. Injuries in Whitewater Kayaking. ***British Journal of Sports Medicine, 35*****(4), 235-241.**

This report describes whitewater kayaking injuries on a global scale. The authors distributed a survey at whitewater events and club meetings and on the internet in 1997, requesting data on injuries from the previous 5 years (1992 to 1997). Injury data included mechanism, activity, and severity. A total of 392 responses were included in the final analysis. The most common mechanisms were striking an object (44 percent), traumatic stress (25 percent), and overuse (25 percent). The most common injuries were abrasions (25 percent), tendinitis (25 percent), contusions (22 percent), and dislocations (17 percent). The only significant factor relating to likelihood of injury was exposure, measured in the number of days a year that the sport was pursued; other measured but insignificant factors were sex, age, skill level, and years of kayaking experience.

Florida Fish and Wildlife Conservation Commission. 2011-2020. *Boating Accident Statistics*. Division of Law Enforcement, Tallahassee, FL, USA.

The Boating Accident Statistical Report is compiled by the Boating and Waterways Section of the Fish and Wildlife Conservation Commission (FWC)'s Division of Law Enforcement. Most of the data contained in this report are gathered from boating accident investigative reports submitted by FWC officers and their marine law enforcement partners. At the end of each calendar year, boating accident data are compiled and assembled into this annual report. The FWC analyzes this information and uses it to formulate proactive plans aimed at reducing the number of boating accidents and their related injuries, fatalities and property damage. This information is also reported to the USCG's Boating Safety Division in Washington, D.C., to be included in the national database consisting of data from all U.S. states and territories. The statistics reflect data from "reportable boating accidents" that occurred in Florida in a given year.

Gabbe, B.J., C.F. Finch, P.A. Cameron, & O.D. Williamson. 2005. Incidence of Serious Injury and Death during Sport and Recreation Activities in Victoria, Australia. *British Journal of Sports Medicine*, *39*(8), 573-577.

This article describes the epidemiology of serious injuries sustained in sport/recreation activities, focusing on adults in Victoria, Australia. Patients aged 15 and over with sport/recreation related injury, who presented to hospital for treatment or who died before reaching hospital, were identified from the Victorian State Trauma Registry (VSTR) and the National Coroner's Information Service (NCIS) from July 2001 to June 2003. Water-skiing and power boating accounted for 8.6 percent of the 198 serious injuries and deaths reported. Of the 40 reported deaths, 69 percent were due to drowning, including deaths associated with swimming and other activities that are not necessarily boating-related.

Gabe, T.M. & D. Hite. 2003. The Effects of Boating Safety Regulations. *Coastal Management, 31*, 247-254.

This article investigates the effects of implementing boater education programs and increasing the number of water patrol officers on preventing recreational boating accidents. It focuses on the number of boating accidents rather than injuries. It incorporates data from 49 states and the District of Columbia from 1994 as collected by the Department of Transportation. The findings illustrate that the number of full-time law enforcement officers that patrol State waterways significantly affects the number of boating accidents in a State; an increase of one water patrol officer would prevent about 68 accidents in the average State. The number of hours of boating education was not statistically significant.

Glover, E.D., S. Lane, & M.Q. Wang. 1995. Relationship of Alcohol Consumption and Recreational Boating in Beaufort County, North Carolina. *Journal of Drug Education, 25*(2), 149-157.

This study examines the relationship between alcohol use and recreational boating activities and environmental and social factors such as boater's age, safety education, awareness of the law, and perceptions of alcohol in boating accidents. Researchers gathered data from visitors to public and private docks during the fall and spring seasons through a self-report questionnaire. A total of 211 subjects completed the interview. Results illustrate that 61 percent had previously received boating safety education. A significant relationship was found between receiving safety education and prevalence of alcohol use: boaters with safety education had a higher percentage of alcohol use than boaters without safety education. However, the study does not provide data on related fatal or nonfatal injuries.

Harris, Anna. 2010. ***Casting Beyond the Bow: An Examination of Anglers Fishing From Boats. An Addendum to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.*** **U.S. Fish & Wildlife Service.**

This report provides detailed information on fishing from boats, based on the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Reported data include information on location, boater demographics, boat characteristics, and other factors. However, the study does not provide data on fatal or nonfatal injuries.

Hostetler, S.G., T.L. Hostetler, G.A. Smith, & H. Xiang. 2005. Characteristics of Water Skiing-related and Wakeboarding-related Injuries Treated in Emergency Departments in the United States, 2001-2003. ***American Journal of Sports Medicine, 33*****(7): 1065-1070.**

This report outlines the number of injuries, injury diagnoses, and body regions injured in water skiing and wakeboarding in the United States. The authors assessed data on injuries from the National Electronic Injury Surveillance System (NEISS), including data provided by 98 hospital emergency departments between the beginning of 2001 and the end of 2003. They focused on cases identified using the consumer product code for water skiing, which captures water skiing, wakeboarding, kneeboarding, tubing, and other water sports. They analyzed 517 cases of water skiing-related injuries and 95 cases of wakeboarding-related injuries. The most common injuries for wakeboarders were head injuries (29 percent), primarily facial lacerations. For water skiers, strains or sprains to the lower extremities were the leading injury diagnoses (34 percent). The study emphasizes the potential positive effect of helmets or other protective head gear for wakeboarders and the use of plastic or foam coating for towropes. For water skiing, it emphasizes the need for physical conditioning and education for participants new to the sport.

Howland, J., G.S. Smith, T. Mangione, R. Hingson, W. DeJong, & N. Bell. 1993. Missing the Boat on Drinking and Boating. ***Journal of the American Medical Association, 270*****(1), 91-92.**

This article addresses two questions: 1) whether emphasizing reducing alcohol use by boat operators alone makes sense, given how many fatal boating events occur; and 2) if not, whether the information on drinking and boating actually places people at greater risk because, by focusing on boat operators, it implies that it is safe for passengers to drink or for skippers to drink at anchor. The data analyzed come from the Coast Guard Recreational Boating Statistics report (1991). Based on their review of this source, Howland *et al*. emphasize that fatalities could be attributed to boat operators in no more than 54 percent of the cases; 46 percent of fatalities occurred when vessels were not under way. While safety programs target the operation of vessels while under the influence of alcohol (drunk driving), only 18 percent of fatalities involved collisions with other vessels or fixed floating objects.

Hsieh, J. C. 2020. *A Study of Recreational Boating Public Interventions, Regulations and Accidents Utilizing Federal and State Data*. Johns Hopkins University, Baltimore, USA. Retrieved from jscholarship.library.jhu.edu.

This study evaluates the impacts of public regulations on recreational boating accidents. The author utilizes a combination of public data available from the State of Florida on the maritime domain, public interventions such as aids to navigation, and public regulations. These data are examined with boating accident data to determine if a relationship exists at both a county-level and at the accident-level. The analysis finds that the placement of Aids to Navigation like buoys and channel markers and the issuance of boater safety cards as a result of education completion which are designed to reduce the boating accident rate seemed to have a reverse effect at the county level. Further, when evaluated at the accident level, age, experience and education of a boat operator has a noticeable effect on the probability of injuries and fatalities in boating accidents.

Lawrence, B.A., T.R. Miller, & L. Daniel Maxim. 2006. *Recent Research on Recreational Boating Accidents and the Contribution of Boating Under the Influence: Summary of Results*. Prepared for the U.S. Coast Guard.

This study is discussed in detail in the main body of IEc and Robinson's 2011 report. It estimates the number of recreational boating injuries, with a particular focus on accidents involving alcohol. To address underreporting issues, the authors used data from several databases independent of BARD and found that BARD underreports fatality counts by one percent, nonfatal hospital-admitted boating injuries by 20 percent and nonfatal non-admitted boating injuries by up to 92 percent.

Lunetta, P., A. Penttila, & S. Sarna. 1998. Water Traffic Accidents, Drowning and Alcohol in Finland, 1969-1995. *International Journal of Epidemiology, 27,* 1038-1043.

This study examines age- and sex-specific mortality rates and trends in water traffic accidents and their association with alcohol in Finland. It is based on national data from 1969 to 1995. Of the 3,473 boating fatalities during this time, 95 percent were due to drowning. Alcohol intoxication was a contributing factor in 63 percent of these incidents. The overall mortality rates in water traffic accidents as well as those associated with alcohol intoxication both declined significantly over the years studied.

Mangione, T.W., J. Howland, S. Stowman, S. Lambou, & D. Tsouderos. 2000. *1998 National Recreational Boating Survey Data Book*. An Aquatic Resources Trust Fund (Wallop-Breaux) report for the U.S. Coast Guard. Prepared by JSI Research & Training, Boston, MA.

This report presents summary tables of the results of a mail survey of licensed boat owners in each State, which was implemented to obtain information on levels and types of boating activity, use of safety devices and safety behaviors, and boaters' opinions on a variety of safety policy initiatives.

Maxim, D.L. 2010. Drownings Avoided by Using Life Jackets: Working Paper.

This working paper discusses approaches for estimating drownings avoided as a result of increased wear rates for life jackets. It presents an extension of a model used by NHTSA for estimating lives saved due to the use of motorcycle helmets or seat belts or the presence of air bags. It relies on data from BARD for open motorboats in 2008 and matching life jacket wear rate data from a survey sponsored by USCG, to estimate the parameters of a function that can be used to predict drownings averted under different conditions.

Molberg, P.J., R.S. Hopkins, J. Paulson, & R.A. Gunn. 1993. Fatal Incident Risk Factors in Recreational Boating in Ohio. *Public Health Reports, 108*(3), 340-346.

The goal of this study is to identify risk factors predicting the involvement of boat operators in incidents resulting in at least one fatality. Data on boating incidents were obtained from BARs compiled by the Ohio Division of Watercraft from 1983 to 1986. The authors reviewed Ohio death certificates to detect deaths related to water transport that did not appear in BAR. No additional recreational boating fatalities were found in the death certificates and 40 percent of fatal incidents would have been missed by searching solely the death certificates. In addition, the authors collected risk factor data from 759 registered boaters in a mail survey in 1986. Results indicate that operator age (<30 years) and experience (<20 hours) were independently associated with the risk of being in a fatal accident. Training (none vs. some) and boat type were not significantly associated with risk when controlling for age and experience. Hours of experience were significantly more influential than any other factor. Canoes, kayaks, rowboats, and inflatables were associated with a higher fatality rate than motorboats.

Nathanson, A.T., J. Baird, & M. Mello. 2010. Sailing Injury and Illness: Results of an Online Survey. *Wilderness and Environmental Medicine, 21*(4), 291-297.

The purpose of this study was to describe the relative frequency, patterns, and mechanisms of sailing-related injuries in dinghies and keelboats. Data were also collected on risky and risk-averse behaviors of sailors, and on sailing-related illnesses. Information was gathered via an online survey from March through November of 2006 that focused on injuries or illnesses sustained over the past 12 months. Tacking, heavy weather, and jibing were the most common factors contributing to injury. The rates of injury and severe injury in the internet-based survey were 4.6 and 0.57 per 1000 days of sailing, respectively. Of the total injured, 7 percent of sailors reported use of alcohol within the 2 hours preceding injury.

National Transportation Safety Board. 1998. *Personal watercraft safety, Safety study NTSB/SS-98/01*. Washington, D.C.: NTSB.

The purpose of this study was to investigate the characteristics of injuries and fatalities from accidents specifically for personal watercraft in order to make safety recommendations to USCG, personal watercraft (PWC) manufacturers, and others. The study, however, was not intended to estimate the frequency of personal watercraft accidents, or to be representative of all personal watercraft accidents, but instead to use a subset of accident data to study unique safety characteristics of this type of recreational boat. The study revealed that there appears to be a high risk of injury with PWC use, that there is a low level of safety instruction and training among operators of PWC, and that a high usage of PFDs seemed to correlate with a low number of drowning fatalities from PWC accidents.

Neville, V. & J.P. Folland. 2009. The Epidemiology and Aetiology of Injuries in Sailing. *Sports Medicine, 39*(2), 129-145.

This report provides detailed statistics on the types and causes of sailing-specific injuries, based on work conducted by the School of Sport and Exercise Sciences at Loughborough University in the UK. The data are divided into categories based on level of experience (Olympic class vs. Novice/recreational), position (e.g., helmsmen vs. mastmen), and type of sailing activity (e.g., windsurfing, offshore racing). Neville and Folland found that injuries are predominantly acute, with contusions and abrasions typically occurring as a result of collisions with the boom or other equipment.

O'Connor, Peter. 2002. *Assessment of Fatal and Non-fatal Injury Due to Boating in Australia.* National Marine Safety Committee, Australia.

This publication presents national statistics on boating injuries and fatalities in Australia, based on data collected from hospitals and the Australian Bureau of Statistics (ABS). Death data from ABS extends from 1979-1998, while the hospital admission statistics are from 1993-94 only. The hospital data are limited to ICD cause codes E830-838 ('water transport accidents') and E910.0 ('accidental drowning and submersion while water skiing'); they include bed-days and average length of stay to facilitate assessment of total healthcare burden per incident. Results are presented graphically, including fatalities and hospital admissions due to injuries. The authors found that fatalities have dropped over the past 20 years, but injuries have remained constant.

Owens, P. L., M. L. Barrett, T. B. Gibson, R. M. Andrews, R. M. Weinick, R. L. Mutter. 2010. Emergency department care in the United States: A profile of national data sources. *Annals of Emergency Medicine*, *56*(2), 150-165.

This article compares 7 data sources available in 2005 for conducting analyses of emergency department (ED) encounters: the American Hospital Association Annual Survey Database, Hospital Market Profiling Solution, National Emergency Department Inventory, Nationwide Emergency Department Sample, National Hospital Ambulatory Medical Care Survey, National Electronic Injury Surveillance System-All-Injury Program, and the National Health Interview Survey. In addition to describing the type and scope of data collection, available characteristics, and sponsor of the ED data sources, the authors compare estimates of the total number of EDs, national and regional volume of ED visits, national and regional admission rates (percentage of ED visits resulting in hospital admission), patient characteristics, hospital characteristics, and reasons for visit generated by the various data sources.

Rizzo, M.G., Desai, S.S., Benson, D.C. et al. 2022. Watercraft propellers as a mechanism of orthopaedic injuries: injury patterns, management, and complications. *European Journal of Trauma and Emergency Surgery* 48, 2469–2476.

This study describes and analyzes the range of orthopedic injuries sustained from watercraft propeller among recreational boaters in the United States, with a particular focus on the mechanism, injury pattern, management, and complications associated with these injuries. The study reviews 42 patients who sustained injuries from watercraft propeller that presented to a level 1 trauma center. Data reviewed include patient demographics, mechanism of injury, surgical management, antibiotic use, and complications. The study found that watercraft propellers often result in injuries with high rates of open fractures and neurovascular injury, necessity for multiple surgeries, and extended length of hospital stays.

Rubin, L.E., P.B. Stein, C. DiScala & B.E. Grottkau. 2003. Pediatric Trauma Caused by Personal Watercraft: A Ten-Year Retrospective. *Journal of Pediatric Surgery, 38*(10): 1525-1529.

This report provides statistics on the causes, types, and results of personal watercraft injuries to minors in the United States. The authors compile data from trauma registry charts on 66 children (age 5 to 19) hospitalized for personal watercraft-related injuries between 1990 and 1999, based on the National Pediatric Trauma Registry. They find that 70 percent of injuries resulted from collisions with another personal watercraft, boat, or fixed object; 55 percent of injuries involved the head, face, or neck; 72 percent occurred to the operator of the personal watercraft; 83 percent required surgery; and 42 percent required admission to the intensive care unit. Ultimately 6 percent (4) of the children died, and 42 percent (28) were disabled.

Ryan, K. M., A. T. Nathanson, J. Baird, & J. Wheelhouse. 2016. Injuries and fatalities on sailboats in the United States 2000–2011: An analysis of US coast guard data. *Wilderness & Environmental Medicine*, *27*(1), 10-18.

This large, population-based study examines the mechanisms and factors contributing to sailboat-related injuries and deaths. The authors perform a retrospective data analysis of the Boating Accident Report Database compiled by the US Coast Guard between 2000 and 2011. The database is analyzed looking at frequency of events. These data, used in conjunction with the 2011 US Coast Guard National Recreational Boating Survey, are used to estimate a fatality rate.

Schlotthauer, A. 2019. The Recreational Boat Occupant Injury Surveillance Roundtable. *National Association of State Boating Law Administrators (NASBLA).* Washington, D.C.

The Recreational Boat Occupant Injury Surveillance Roundtable is Tier 1 of a three-tiered approach to improve boat occupant injury surveillance practices nationally. The roundtable process was organized and convened by the Safe States Alliance and the NASBLA to support the USCG in carrying out their National Recreational Boating Safety Program 2017-2021 Strategic Plan. Recreational boating safety and public health experts assembled to: 1.) Discuss current efforts to improve recreational boating-related injury data collection and analyses; 2.) Examine data sources that could be used to monitor recreational boating-related injuries at the national, state and local jurisdictional levels; 3.) Describe at-risk populations for recreational boat occupant injuries; 4.) Identify key limitations and barriers in the collection and use of existing data sources; 5.) Share innovative approaches used in states and communities to address barriers; 6.) Identify key opportunities for improving and standardizing surveillance related to recreational boat occupant injuries and fatalities; 7.) Develop stronger relationships between public health and recreational boating safety professionals.

Smith, G.S., C. Coggan, T. Koelmeyer, P. Patterson, V. Fairnie, & A. Gordon. 1999. *The Role of Drowning and Boating Deaths in the Auckland Region: Boating (1980-1997) and All Drownings (1988-1997).* An updated report to ALAC, Auckland: Injury Prevention Research Center.

The aims of this study are: 1) to document the role of alcohol in drowning deaths in Auckland for the period 1988-1997; 2) to provide more detail on boating deaths for a longer time period (1980-1997); 3) to evaluate the quality of the available data on the relationship between alcohol use and drowning and boating deaths; and 4) to provide background data for planning programs to reduce alcohol-related injuries associated with aquatic activities. The researchers identified possible drownings in the Auckland area between 1988 and the end of 1997 from the records of the Auckland University Department of Pathology. A total of 112 boating cases were included. Among boating fatalities involving victims 15-64 years of age, they found that 43.2 percent had a positive blood alcohol content and 27.3 percent had a blood alcohol content over the legal driving limit in New Zealand. For falls overboard in recreational boating, 67 percent were intoxicated, which was almost two and a half times higher than for all boating fatalities.

Smith, G.S., P.M. Keyl, J.A. Hadley, C.L. Bartley, R.D. Foss, W.G. Tolbert, & J. McKnight. 2001. Drinking and Recreational Boating Fatalities: A Population-Based Case-Control Study. ***Journal of the American Medical Association, 286*****(23), 2974-2980.**

This study seeks to better define the relationship between alcohol use and the relative risk of death while boating. The data are from official state boating fatality records and medical examiner files in Maryland and North Carolina, and include all recreational boating deaths classified as "accidental" that occurred from April to October of 1990-1998. Deaths associated with sailboats, rafts, and personal watercraft are excluded; individuals who drowned while swimming from a boat were included. Of the 221 fatality subjects included in the study, 55 percent had a positive blood alcohol content and less than half were operators. Results demonstrate that the odds ratios for dying by blood alcohol content increased most rapidly at lower blood alcohol content levels. However, when only those persons meeting the official USCG definition of boating accidents were considered (excludes swimmers), there was no significant change in the relative risk of fatality. The majority of fatalities involved falling overboard, and 46 percent of these occurred while the vessel was not underway. The relative risk of death is therefore similar for operators and passengers and increases for both groups as blood alcohol content increases.

Stempski, S., M. Schiff, E. Bennett, & L. Quan. 2014. A case–control study of boat-related injuries and fatalities in Washington State. ***Injury Prevention*****,** ***20*****(4), 232-237.**

This is a case–control study that uses the Washington Boat Accident Investigation Report Database for 2003 to 2010. Cases were fatally injured boat occupants, and controls were nonfatally injured boat occupants involved in a boating incident. The authors evaluated the association between victim, boat and incident factors and risk of death. The study found that, of 968 injured boaters, 26 percent died. Fatalities were 2.6 times more likely to not be wearing a PFD and 2.2 times more likely to not have any safety features on their boat compared with those who survived. Boating fatalities were more likely to be in a non-motorized boat, to have alcohol involved in the incident, to be in an incident that involved capsizing, sinking, flooding or swamping, and to involve a person leaving the boat voluntarily, being ejected or falling than those who survived.

Strategic Research Group. 2003. ***2002 National Recreational Boating Survey Report*****. United States Coast Guard; USCG Office of Boating Safety.**

This National Recreational Boating Survey (NRBS) was conducted by SRG in 2001-2002. The final results consist of 25,547 surveys completed by boat operators. The report provides detailed statistics on: boating experience, boating knowledge, most often used boats, activities on boats, boating safety knowledge and experience, PFD usage, boating incidents, predictors of involvement in a boating incident, predictors of participation in a boating safety course, and predictors of PFD use. Less than 1 percent of boat operators were involved in an accident resulting in property damage; 1 percent experienced a serious injury. Open motorboats accounted for 37 percent of property damage and 50 percent of injuries requiring treatment beyond first aid. Personal watercraft accounted for 14 percent of property damage and 21 percent of injuries.

Swett, R., C. Sidman, T. Fik, R. Watkins, & P. Ouellette. 2011. Evaluating Boating Safety Risk in Intracoastal Waterways. *Coastal Management*. 613-6627.

Growth in the number of recreational vessels that use inland and coastal waterways, coupled with the diversity of boating activities, results in increased boating-related conflicts, accidents, and fatalities. This risk assessment paper uses geospatial data compiled from multiple government agencies, survey data from subject matter experts, and public input from participatory workshops. Relevant spatial data includes waterway features and marine infrastructure from field surveys, vessel traffic patterns observed and mapped from aerial reconnaissance, and indicators of boater behaviors extracted from accident and citation reports. These data are used to characterize waterway segments in Florida according to perceived risk to boating safety. The application was tested in two Florida counties and helped guide the establishment of new, and the revision of existing, boating regulatory zones within their Intracoastal Waterways.

Talley, W.K. 1994. Recreational Boating Fatality Rates and State Anti-Alcohol Boating Laws. *Transportation Quarterly, 48*(3), 311-314.

This study explores the effectiveness of State anti-alcohol boating laws on recreational boating fatality rates. Talley utilizes the annual fatality rate data for 16 States over an 8-year period, 1980 to 1987, as obtained through a survey conducted by NASBLA. Results show a reduction in fatality rates ranging from 1.7 percent to 50.1 percent across the 16 States following the enactment of anti-alcohol boating laws, with an average percentage decline of 29.7 percent.

U.S. Coast Guard, U.S. Department of Homeland Security. 1999-present. *Recreational Boating Statistics*. Washington, DC: USCG.

These annual reports (referenced in Chapter 1 and discussed in detail in IEc and Robinson (2011)) contain statistics on recreational boating accidents and State vessel registration. They include data from all States as well as the District of Columbia, Puerto Rico, Guam, the Virgin Islands, American Samoa, and the Commonwealth of the Northern Mariana Islands, including data on fatalities, injuries, and property damage. Statistics cover accident types, causes, and conditions; operator/passenger information; and registration data.

Virk, A. & T.J. Pikora. 2011. Developing a Tool to Measure Safe Recreational Boating Practice. *Accident Analysis and Prevention, 43,* 447-450.

This study develops a boating safety scale to measure safe boating practices and allow the identification of factors influencing safety behavior among recreational boaters. Virk and Pikora draw on a database of all recreational vessels registered in Western Australia. They recruited a sample of 1,002 adult boaters to participate in a telephone survey. Answers to the questionnaire were weighted and calculated as a boating safety scale score, with higher scores indicating a higher level of boating safety behavior. The range of scores was between 6 percent and 100 percent, with a mean of 68 percent and median of 71 percent. The results indicate offsetting behavior: increased confidence that is gained through experience may result in less cautious behavior among boaters.

Wang, Weiren. 2000. The Effects of State Regulations on Boating Accidents and Fatalities. *Applied Economics Letters, 7,* 373-378.

This source addresses the effectiveness of an array of variables in reducing recreational boating accidents and fatalities. The author analyzes State regulations on recreational boating and USCG boating statistics from 1990 to 1994 for 49 states (excludes Alaska) and the District of Columbia. The study focuses on boating educational programs, PFDs, and alcohol. The author finds that minimum operating age and school education (public school courses targeting youth) are the most salient variables.

Willcox-Pidgeon, S., A. E. Peden, R.C. Franklin, & J. Scarr. 2019. Boating-related drowning in Australia: Epidemiology, risk factors and the regulatory environment. *Journal of Safety Research*, *70*, 117-125.

This study reports on unintentional fatal drowning associated with boating-related incidents in Australia. A total population, retrospective, cross sectional design examined all boating-related unintentional drowning deaths between July 1, 2005, and June 30, 2015. Variables examined included age, sex, location of drowning incident, vessel type, activity, presence of alcohol/drugs, and lifejacket wear.

A.2 BOATING-RELATED PROPERTY DAMAGE

Lawrence, B.A., T.R. Miller, & L. Daniel Maxim. 2006. *Recent Research on Recreational Boating Accidents and the Contribution of Boating Under the Influence: Summary of Results*. Prepared for the U.S. Coast Guard.

See Section 1 of this appendix.

Marine Index Bureau Foundation, Inc. (MIBF) 1995. *1994 R-BAR Final Report*. Funded under the Wallop-Breaux Trust Fund, administered by the U.S. Coast Guard.

This report is discussed in detail in the main body of IEc and Robinson's 2011 report. It describes the 1994 data collection year results of the R-BAR program, conducted under a grant from USCG. The R-BAR program uses insurance industry claims information collected from 19 participating insurers to provide a supplemental picture of losses from recreational boating accidents. The program focuses specifically on injury and property damage accidents (as opposed to fatalities). The report concludes that there were a significant number of reportable property damage and bodily injury incidents that were not reported to the USCG. The R-BAR project also established that the insurance industry can be a valuable resource for data on property damage and injury from recreational boating accidents.

U.S. Coast Guard Office of Auxiliary and Boating Safety. August 2021. *Draft report: A Study of Underreporting.* Washington, DC: USCG.

In May 2018, personnel from USCG and Insurance Company "X" initiated a project to study underreporting in recreational boating accidents. USCG studied 4 years of insurance claims for Florida and Minnesota as well as accident reports in BARD. USCG personnel plan to create a model to gauge underreporting and investigate reasons accidents are underreported. IT expects that the findings of this study will better illustrate risk, and likely will be used for regulatory purposes and public awareness. To date, USCG has found that 1) the number of claims represented in BARD is low; 2) for those matches, there is a damage discrepancy between sources; 3) the reasons for underreporting in BARD likely involve a number of factors including the public's unawareness of reporting requirements and the public's disinterest in reporting; 4) there is a general sentiment that collecting information on damage-only accidents is worthwhile; and 5) proposed solutions to account for underreporting include building a model to adjust for underreporting.

U.S. Coast Guard. U.S. Department of Homeland Security. 1999-present. *Recreational Boating Statistics*. Washington, DC: USCG.

See Section 1 of this appendix.

APPENDIX B | DATABASE DESCRIPTIONS

In this Appendix, we provide summary information about potentially relevant health databases. Exhibit B-1 summarizes the key features of each database, including: source, geographic coverage, geographic resolution (e.g., "statewide" if the data are presented by state), ages covered, diagnosis and injury coding, boating related causes of injury, frequency of data collection, and the website that can be used to access the database.

We also provide brief descriptions of each database. The databases are listed in the same order as in Exhibit B-1, beginning with the national databases, and then the State and other databases. For each database, we indicate the source, provide a brief overview, and discuss its coverage.

To complete our analysis of potential underreporting of fatalities and nonfatal injuries occurring in Florida, we purchased data for years 2014-2019 from the following sources:

- Fatalities: NVSS
- Hospitalizations: HCUP-SID; and
- Emergency room visits: HCUP-SEDD

To attempt our analysis of potential underreporting of nonfatal injuries occurring in Minnesota, we purchased data for years 2014-2019 from the following sources:

- Hospitalizations: HCUP-SID; and
- Emergency room visits: HCUP-SEDD

EXHIBIT B-1. DATABASE DESCRIPTIONS

NAME OF DATABASE	SOURCE	GEOGRAPHIC RESOLUTION	GEOGRAPHIC COVERAGE[38]	AGES COVERED	DIAGNOSIS AND INJURY CODING[39]	BOATING RELATED CAUSES[40]	FREQUENCY OF COLLECTION	URL
NATIONAL DATABASES								
National Vital Statistics System (NVSS)[41]; Multiple Causes of Death (MCOD)	Centers for Disease Control and Prevention (CDC)	Statewide	US (50 States and District of Columbia)	All	ICD-10-CM	V90-V94	Annual	http://www.cdc.gov/nchs/nvss/about_nvss.htm
National Ambulatory Medical Care Survey (NAMCS)[42]	CDC	Regional (Northeast, Midwest, South, West)	US (50 States and District of Columbia)	All	ICD-10-CM[43]	V90-V94; E830-E838; Not available after 2004	Annual	http://www.cdc.gov/nchs/ahcd/about_ahcd.htm#NAMCS
National Hospital Ambulatory Medical Care Survey (NHAMCS)[44]	CDC	Regional	US (50 States and District of Columbia)	All	ICD-10-CM[45]	V90-V94; E830-E838	Annual	http://www.cdc.gov/nchs/ahcd/about_ahcd.htm#NAMCS

[38] Florida is included in all datasets/databases with fewer than 50 states.

[39] For more information, see http://www.cdc.gov/nchs/injury/injury_matrices.htm.

[40] The 9th version of the International Statistical Classification of Diseases (ICD-9-CM) includes the following cause-of-injury codes: Accident to watercraft causing submersion (E830); Accident to watercraft causing other injury (E831); Other accidental submersion or drowning in water transport accident (E832); Fall on stairs or ladders in water transport (E833); Other fall from one level to another in water transport (E834); Other and unspecified fall in water transport (E835); Machinery accident in water transport (E836); Explosion, fire, or burning in watercraft (E837); and Other and unspecified water transport accident (E838). Other ICD-9-CM codes may be relevant for this project; including accidental drowning and submersion while water skiing (E910.0). ICD-10 includes the following cause-of-injury codes: Accident to watercraft causing drowning and submersion (V90); Accident to watercraft causing other injury (V91); Water-transport-related drowning and submersion without accident to watercraft (V92); Accident onboard watercraft without accident to watercraft, not causing drowning and submersion (V93); and Other and unspecified water transport accidents (V94).

[41] Data are publicly available from CDC. Fatality data can be accessed using **WISQARS** (Web-based Injury Statistics Query and Reporting System) at http://www.cdc.gov/injury/wisqars/index.html and WONDER (Wide-ranging Online Data for Epidemiologic Research) at http://wonder.cdc.gov/cmf-icd10.html.

[42] Data are publicly available from CDC. The NAMCS database is available for download at http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm.

[43] The International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) was used to code NAMCS data on physician diagnosis and cause of injury from 2016 onward. It replaced the International Classification of Diseases, Ninth Revision (ICD-9-CM), which had been used to code NAMCS data since 1979.

[44] Data are publicly available from CDC. The NHAMCS database is available for download at http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm.

[45] The ICD-10-CM was used to code NHAMCS data on physician diagnosis and cause of injury from 2016 onward. It replaced the ICD-9-CM.

NAME OF DATABASE	SOURCE	GEOGRAPHIC RESOLUTION	GEOGRAPHIC COVERAGE38	AGES COVERED	DIAGNOSIS AND INJURY CODING[39]	BOATING RELATED CAUSES[40]	FREQUENCY OF COLLECTION	URL
National Hospital Discharge Survey (NHDS)	CDC	Regional	US (50 States and District of Columbia)	All	ICD-10-CM	V90-V94; E830-E838 (approx. 20 States)	Annual	http://www.cdc.gov/nchs/nhds/about_nhds.htm
National Health Interview Survey (NHIS)	CDC	Regional	US (50 States and District of Columbia)	All	ICD-10-CM	V90-V94; E830-E838 (50 States)	Annual	http://www.cdc.gov/nchs/nhis/about_nhis.htm
Nationwide Inpatient Sample (HCUP-NIS)[46]	Agency for Health Care Research and Quality (AHRQ), compiled from State Inpatient Databases (SID)	Statewide (1997-2012); Regional (2012-2019)	US (48 States)	All	ICD-10-CM[47]	V90-V94; E830-E838 (approx. 28 States)	Annual	http://www.hcup-us.ahrq.gov/nisoverview.jsp
Nationwide Emergency Department Sample (HCUP-NEDS)[48]	AHRQ, compiled from State Emergency Department Databases (SEDD) and SID	Statewide (1997-2012); Regional (2012-2019)	US (36 States)	All	ICD-10-CM	V90-V94; E830-E838 (approx. 20 States)	Annual	http://www.hcup-us.ahrq.gov/nedsoverview.jsp
Kids' Inpatient Database (HCUP-KID)[49]	AHRQ	Statewide (1997-2012); Regional (2012-2019)	US (46 States)	Patients 20 years and under	ICD-10-CM	V90-V94; E830-E838 (approx. 26 States)	Every 3-4 years	http://www.hcup-us.ahrq.gov/kidoverview.jsp
Medical Expenditure Panel Survey (MEPS)[50]	AHRQ	Regional	US (50 States and District of Columbia)	All	ICD-10-CM	No, drowning only	Annual	http://www.meps.ahrq.gov/mepsweb/

[46] Data are publicly available from AHRQ. National estimates of injuries can be obtained using web-based queries at http://hcupnet.ahrq.gov/.

[47] Beginning with data year 2016, the NIS contains a full year of ICD-10-CM/PCS codes. The data are split in 2015 between ICD-9-CM and ICD-10-CM codes because of the transition to ICD-10-CM codes on October 1, 2015.

[48] Data are publicly available from AHRQ. National estimates of injuries can be obtained using web-based queries at http://hcupnet.ahrq.gov/. This online search tool is a Beta version.

[49] Data are publicly available from AHRQ. National estimates of injuries can be obtained using web-based queries at http://hcupnet.ahrq.gov/.

[50] Data are publicly available from AHRQ. Nationally representative statistics of health care use, expenditures, and sources of payment can be obtained using web-based queries at http://www.meps.ahrq.gov/mepsweb/data_stats/meps_query.jsp.

NAME OF DATABASE	SOURCE	GEOGRAPHIC RESOLUTION	GEOGRAPHIC COVERAGE38	AGES COVERED	DIAGNOSIS AND INJURY CODING[39]	BOATING RELATED CAUSES[40]	FREQUENCY OF COLLECTION	URL
National Electronic Injury Surveillance System (NEISS)[51]	U.S. Consumer Product Safety Commission (CPSC)	National	US (approx. 48 States)	All	NEISS	No; only waterskiing, wake boarding, tubing, and surfing	Annual	http://www.cpsc.gov/library/neiss.html
Medicare Hospital Inpatient Prospective Payment System (IPPS)	HHS Centers for Medicare and Medicaid Services (CMS)	Statewide	US (50 States and District of Columbia)	Medicare Beneficiaries	ICD-10-CM	V90-V94; E830-E838	Semi-annual	https://www.cms.gov/AcuteInpatientPPS/
Medicare Hospital Outpatient Prospective Payment System (OPPS)	HHS; CMS	Statewide	US (50 States and District of Columbia	Medicare Beneficiaries	ICD-10-CM	V90-V94; E830-E838	Semi-annual	https://www.cms.gov/LimitedDataSets/06_HospitalOPPS.asp#TopOfPage
National Syndromic Surveillance Program (NSSP)	CDC	County	49 states and the District of Columbia	All	ICD-10-CM[52]	V90-V94; E830-E838	Within 24 hours of patient visit	https://www.cdc.gov/nssp/overview.html

[51] Data are publicly available from CDC. Nonfatality data can be accessed using **WISQARS** (Web-based Injury Statistics Query and Reporting System) at http://www.cdc.gov/injury/wisqars/index.html.

[52] Prior to data year 2015, NSSP contains ICD-CM-9 codes rather than ICD-10-CM codes.

NAME OF DATABASE	SOURCE	GEOGRAPHIC RESOLUTION	GEOGRAPHIC COVERAGE38	AGES COVERED	DIAGNOSIS AND INJURY CODING[39]	BOATING RELATED CAUSES[40]	FREQUENCY OF COLLECTION	URL
STATE DATABASES								
State Inpatient Database (HCUP-SID)[53]	AHRQ	Statewide	49 States[54]	All	ICD-10-CM[55]	V90-V94; E830-E838 (approx. 28 States)	Annual	http://www.hcup-us.ahrq.gov/sidoverview.jsp
State Emergency Department Database (HCUP-SEDD)[56]	AHRQ	Statewide	42 States[57]	All	ICD-10-CM[58]	V90-V94; E830-E838 (approx. 20 States)	Annual	http://www.hcup-us.ahrq.gov/seddoverview.jsp
State Ambulatory Surgery Databases (SASD)	AHRQ	Statewide	35 States	All	ICD-10-CM[59]	V90-V94; E830-E838 (approx. 23 States)	Annual	http://www.hcup-us.ahrq.gov/sasdoverview.jsp
All Payer Claims Database (APCD)	State-level agencies, no national clearinghouse	Statewide	18 States currently, 30 States in progress	All	Variation across States For MN, 3-digit ICD-9 and 3-digit ICD-1060	V90-V94	Monthly	https://www.ahrq.gov/data/apcd/index.html For MN: https://www.health.state.mn.us/data/apcd/index.htm
OTHER DATABASES								

[53] Data are publicly available from AHRQ. Estimates of injuries for 35 States can be obtained using web-based queries at http://hcupnet.ahrq.gov/.

[54] This number may differ from the number of States reporting in the National database because not all States make SID files available for purchase through the HCUP Central Distributor.

[55] Beginning with data year 2016, HCUP-SID contains a full year of ICD-10-CM/PCS codes. The data are split in 2015 between ICD-9-CM and ICD-10-CM codes because of the transition to ICD-10-CM codes on October 1, 2015.

[56] Data are publicly available from AHRQ. Estimates of injuries for 7 States can be obtained using web-based queries at http://hcupnet.ahrq.gov/. This online search tool is a Beta version.

[57] This number may differ from the number of States reporting in the National database because not all States make SEDD files available for purchase through the HCUP Central Distributor.

[58] Beginning with data year 2016, HCUP-SEDD contains a full year of ICD-10-CM/PCS codes. The data are split in 2015 between ICD-9-CM and ICD-10-CM codes because of the transition to ICD-10-CM codes on October 1, 2015.

[59] The SASD are calendar year files based on discharge date for all data years except 2015. Because of the transition to ICD-10-CM/PCS on October 1, 2015, the 2015 SASD are split into two parts. From 2016 onward, SASD contains ICD-10-CM/PCS codes.

[60] Beginning with data year 2016, MN APCD contains a full year of ICD-10-CM/PCS codes. The data are split in 2015 between ICD-9-CM and ICD-10-CM codes because of the transition to ICD-10-CM codes on October 1, 2015. Prior to data year 2015, all years of data contain ICD-9-CM codes.

NAME OF DATABASE	SOURCE	GEOGRAPHIC RESOLUTION	GEOGRAPHIC COVERAGE38	AGES COVERED	DIAGNOSIS AND INJURY CODING[39]	BOATING RELATED CAUSES[40]	FREQUENCY OF COLLECTION	URL
National Trauma Data Bank (NTDB)	American College of Surgeons Committee on Trauma (ACSCOT)	Statewide	US (approx. 41 States)	All	ICD-10-CM	V90-V94	Annual	https://www.facs.org/quality-programs/trauma/tqp/center-programs/ntdb

HEALTH DATABASES

NATIONAL DATABASES

1) NATIONAL VITAL STATISTICS SYSTEM (NVSS)

Source: Centers for Disease Control and Prevention (CDC)

Overview: The National Center for Health Statistics (NCHS) relies on NVSS to collect and disseminate the Nation's official vital statistics.[61] Data are based on death certifications from State health departments, using standard data collection forms and procedures. NCHS publishes numerous reports based on these data, including an annual report on U.S. deaths, death rates, life expectancy, leading causes of death, and infant mortality. National fatal injury totals can be obtained using web-based queries at http://www.cdc.gov/injury/wisqars/index.html or http://wonder.cdc.gov/.

Coverage: NVSS records U.S. fatalities in 50 States and the District of Columbia. The number of fatalities recorded on death certificates is fully reported, however cause of death information is missing for fewer than 1 percent of records. The most recent publication year is 2019 (although provisional mortality data has been published for 2020). ICD-10 cause-of-injury codes are used to identify drowning and boating-related deaths.

2) NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS)

Source: CDC

Overview: NAMCS is a national survey that provides information on the provision and use of ambulatory medical care services in the United States.[62] It is based on a sample of visits to office-based physicians who are not federally employed and who are engaged primarily in direct patient care. The survey has been conducted annually since 1989. Specially trained interviewers visit the physicians to provide them with survey materials and instruct them in how to complete the forms. Each physician is randomly assigned to a 1-week reporting period. During this period, data for a systematic random sample of visits are recorded by the physician or office staff, including data on patients' symptoms, physicians' diagnoses, and medications ordered or provided. The respondent also provides statistics on the demographic characteristics of patients and the services provided, including diagnostic procedures, patient management, and planned future treatment. The

[61] http://www.cdc.gov/nchs/nvss/about_nvss.htm

[62] http://www.cdc.gov/nchs/ahcd/about_ahcd.htm

NAMCS database is available for download at http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm.

Coverage: NAMCS is a U.S. national probability sample survey of visits to office-based physicians. In 2018, 1,647 physicians were included in the NAMCS sample with 9,953 Patient Record Forms received at office-based and community health centers. ICD-10 codes were used to code NAMCS data on physician diagnosis and cause of injury from 2016 onward. It replaced the International Classification of Diseases, Ninth Revision (ICD-9-CM), which had been used to code NAMCS data since 1979. Notably, after 2004, estimates are in terms of visits and not persons—the survey counts "injury visits" not "injury episodes" (i.e., an episode may entail multiple visits).

3) NATIONAL HOSPITAL AMBULATORY MEDICAL CARE SURVEY (NHAMCS)

Source: CDC

Overview: NHAMCS is designed to collect data on the utilization and provision of ambulatory care services in hospital emergency and outpatient departments.[63] It is based on a national sample of visits to the emergency departments and outpatient departments of non-institutional general and short-stay hospitals. Specially trained interviewers visit facilities to explain survey procedures, verify eligibility, develop a sampling plan, and train staff in data collection procedures. The survey can be completed in five minutes and is provided in two versions – one for the emergency department and one for the outpatient department, which are completed for a systematic random sample of patient visits during a randomly assigned four-week reporting period. Data are obtained on demographic characteristics of patients, expected source(s) of payment, patients' complaints, diagnoses, diagnostic/screening services, procedures, medication therapy, disposition, types of providers seen, causes of injury, and certain characteristics of the facility, such as geographic region and metropolitan status. The NHAMCS database is available for download at http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm.

Coverage: NHAMCS is a U.S. national probability sample survey of visits to emergency departments and outpatient departments. Data are collected in 50 States and the District of Columbia. In 2018, 20,291 Patient Record forms were provided electronically by a sample of 279 hospitals. ICD-10-CM cause-of-injury codes are included for emergency department visits but are not reported in all cases. ICD-10 codes replaced ICD-9 codes from 2016 onwards. Notably, after 2005, NHAMCS does not report cause-of-injury codes for visits to outpatient departments. The survey counts "injury visits" not "injury episodes" (i.e., an episode may entail multiple visits).

4) NATIONAL HOSPITAL DISCHARGE SURVEY (NHDS)

Source: CDC

Overview: NHDS was a national probability survey that provided information on characteristics of inpatients discharged from non-Federal short-stay hospitals located in

[63] http://www.cdc.gov/nchs/ahcd/about_ahcd.htm

the United States. Two data collection procedures were used in the survey. One was a manual system where the data were collected by the U.S. Bureau of the Census; the other was an automated system for which NCHS purchases electronic data files from commercial organizations, State data systems, hospitals, or hospital associations. The medical abstract form and the automated data contained items that relate to the personal characteristics of the patient. Administrative items, such as admission and discharge dates (which allowed calculation of length of stay), as well as discharge status, were also included. Because the NHDS was discontinued in 2010, these data have limited overlap with the BARD data years (2010-2019) and therefore limited applicability.

Coverage: NHDS was a survey of inpatient discharges from short-stay hospitals located in 50 States and the District of Columbia. It was conducted annually from 1965-2010. Beginning in 2008, the sample size was reduced to 239 hospitals from about 500. The target sample size was 250 discharges from hospitals that provided data via the manual system and 2,000 discharges from hospitals that provided data via the automated system. When there were multiple diagnoses, NHDS listed the most likely primary diagnosis first; only first-listed injury diagnoses were reported. ICD-9-CM cause-of-injury codes were included for about 20 States but were not reported for all cases.

5) NATIONAL HEALTH INTERVIEW SURVEY (NHIS)

Source: CDC

Overview: NHIS is a cross-sectional household interview survey that collects statistical information on the amount, distribution, and effects of illness and disability in the U.S. and the services rendered for or because of such conditions. Its "Core" questionnaire contains four major components: Household, Family, Sample Adult, and Sample Child. It collects data on topics including health status and limitations, injuries, healthcare access and utilization, health insurance, and income and assets. Due to difference in sampling techniques, NHIS injury estimates are approximately 70 percent of NHAMCS estimates for emergency department injury visits and approximately 130 percent of NHDS estimates for hospitalizations.[64]

Coverage: NHIS is a large-scale household interview survey of a statistically representative sample of the U.S. civilian non-institutionalized population. Interviewers visit 35,000 households and collect data on about 87,500 individuals in all 50 States and the District of Columbia. ICD-10-CM cause-of-injury codes are included for most records from 2015 onwards. Prior to 2015, ICD-9-CM codes were used. Although the NHIS sample is too small to provide state-level data with acceptable precision for each State, selected estimates for most States may be obtained by combining data years.

[64] http://www.cdc.gov/nchs/ppt/nchs2010/31_Chen.pdf

6) NATIONWIDE INPATIENT SAMPLE (HCUP-NIS)

Source: Agency for Health Care Research and Quality (AHRQ)

Overview: HCUP-NIS is the largest all-payer inpatient care database that is publicly available in the United States. It can be used to identify, track, and analyze national trends in health care utilization, access, charges, quality, and outcomes.[65] HCUP-NIS is the only national hospital database with charge information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance, and the uninsured. Inpatient stay records in HCUP-NIS include clinical and resource use information typically available from discharge abstracts. Data elements include patient demographic, clinical, disposition, and diagnostic/procedural information; cause-of-injury (for some States); hospital ID; facility charges; and other facility information. National estimates of nonfatal injuries that resulted in hospitalization can be obtained using web-based queries at http://hcupnet.ahrq.gov/.

Coverage: HCUP-NIS contains data from an approximately 20-percent stratified sample of all discharges from U.S. community hospitals, excluding rehabilitation and long-term acute care hospitals. Prior to 2012, the NIS was a sample of hospitals from which all discharges were retained, rather than a sample of discharge records from all HCUP-participating hospitals. In 2018, the HCUP-NIS was drawn from 48 States, which comprise 97 percent of the U.S. population; however, beginning in 2012, the NIS removed State and hospital identifiers from the datasets. Beginning with data year 2018, data elements derived from the Clinical Classifications Software Refined (CCSR) for ICD-10-CM diagnoses became available in the NIS.

7) NATIONWIDE EMERGENCY DEPARTMENT SAMPLE (HCUP-NEDS)

Source: AHRQ

Overview: HCUP-NEDS provides national estimates of emergency department visits.[66] NEDS is constructed using records from both the State Emergency Department Databases (SEDD) and the State Inpatient Databases (SID).[67] NEDS contains information about geographic characteristics, hospital characteristics, patient characteristics, and the nature of visits (e.g., common reasons for emergency department visits, including injuries). NEDS includes emergency department charge information for over 86 percent of patients, regardless of payer, including patients covered by Medicaid, private insurance, and the uninsured. NEDS includes emergency department visits that did not result in admission (e.g., treated and released, transferred to another hospital, transferred to another type of health facility, left against medical advice, or died in emergency department). National estimates of nonfatal injuries that resulted in hospitalization can be obtained using web-based queries at http://hcupnet.ahrq.gov/.

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[65] http://www.hcup-us.ahrq.gov/nisoverview.jsp

[66] http://www.hcup-us.ahrq.gov/nedsoverview.jsp

[67] The SEDD capture information on emergency department visits that do not result in an admission. The SID contain information on patients initially seen in the emergency department and then admitted to the same hospital.

Coverage: NEDS is the largest all-payer emergency department database in the United States, containing almost 35 million (unweighted) records for emergency department visits for over 990 hospitals, approximating a 20-percent stratified sample of U.S. hospital-based emergency departments. In 2018, 36 States were represented in NEDS. ICD-10-CM cause-of-injury codes are included for about 20 States.

8) KIDS' INPATIENT DATABASE (HCUP-KID)

Source: AHRQ

Overview: HCUP-KID is a database of hospital inpatient stays for patients 21 years and younger. KID is the only all-payer inpatient care database for children in the United States. KID includes charge information on all patients, regardless of payer, including children covered by Medicaid, private insurance, and the uninsured.

Coverage: The 2016 KID contains data drawn from 46 State Inpatient Databases on patients 21 years of age and younger. KID includes a sample of pediatric discharges from over 4,200 U.S. community hospitals and records for over three million general hospital discharges. ICD-10-CM cause-of-injury codes are included for about 26 States in 2016. Prior to 2016, hospital discharge data contained ICD-9-CM codes. While KID focuses exclusively on patients 21 years and younger, these patients are also sampled in the larger HCUP-NIS.

9) MEDICAL EXPENDITURE PANEL SURVEY (MEPS)

Source: AHRQ

Overview: MEPS provides nationally representative estimates of health care use, expenditures, sources of payment, and health insurance coverage for the U.S. civilian non-institutionalized population. MEPS is a set of large-scale surveys of families and individuals—drawn from a nationally representative subsample of households that participated in the prior year's National Health Interview Survey—their medical providers (doctors, hospitals, pharmacies, etc.), and employers. MEPS collects data on the specific health services that Americans use, how frequently they use them, the cost of these services, and how they are paid for, as well as data on the cost, scope, and breadth of health insurance held by and available to U.S. workers. MEPS currently has two major components: the Household Component (HC) and the Insurance Component (IC). The HC provides data from individual households and their members, which is supplemented by data from their medical providers (e.g., dates of visit, diagnosis and procedure codes, charges, and payments). The IC is a separate survey of employers that provides data on employer-based health insurance. MEPS data files are available at http://www.meps.ahrq.gov/mepsweb/data_stats/download_data_files.jsp and data can be obtained using web-based queries at http://www.meps.ahrq.gov/mepsweb/data_stats/meps_query.jsp.

Coverage: MEPS collects detailed information regarding the use and payment for health care services from a nationally representative sample of Americans. Each annual HC sample size is about 13,000-15,000 households. MEPS does not use standard cause-of-injury coding – instead, respondents are asked, "Was the condition due to an accident/injury?" and whether it involved "a motor vehicle, gun, some other weapon, poisoning/poisonous substance, fire/burn, drowning/near drowning, sports injury, fall, or something else."

10) NATIONAL ELECTRONIC INJURY SURVEILLANCE SYSTEM (NEISS)

Source: CPSC

Overview: NEISS provides data on consumer product-related injuries occurring in the United States. NEISS is a national probability sample of hospitals across the country.[68] Patient information is collected from each NEISS hospital for every emergency visit involving an injury associated with consumer products. Injury diagnosis, body parts affected, and a brief narrative description of the incident are included.

Coverage: Injury data are gathered from the emergency departments of over 100 hospitals from approximately 48 States selected as a probability sample of 6,000 U.S. hospitals with emergency departments. NEISS does not identify the full range of boating-related injuries (only water skiing, wakeboarding, tubing, and surfing).

11) MEDICARE HOSPITAL INPATIENT PROSPECTIVE PAYMENT SYSTEM (IPPS)

Source: HHS; CMS

Overview: IPPS contains costs and payment rates for inpatient services furnished to people with Medicare by acute care hospitals and long-term care hospitals in the United States. IPPS contains claims data submitted by inpatient hospital providers for reimbursement of facility costs. Data include ICD-10-CM diagnosis and procedure codes, dates of service, reimbursement amount, hospital provider, and beneficiary demographic information, as well as cause-of-injury codes in some cases.

Coverage: IPPS collects data on the use, payment, and hospital charges for more than 3,000 U.S. hospitals that received IPPS payments in 50 States and the District of Columbia. The data are organized by hospital and Medicare Severity Diagnosis Related Group (DRG). The DRGs included in this dataset represent more than seven million discharges or 75 percent of total Medicare IPPS discharges. ICD-10-CM cause-of-injury codes are included for some claims. The sample population is limited to Medicare beneficiaries.

12) MEDICARE HOSPITAL OUTPATIENT PROSPECTIVE PAYMENT SYSTEM (OPPS)

Source: HHS; CMS

Overview: OPPS contains claims data submitted by institutional outpatient providers, including hospital outpatient departments, rural health clinics, renal dialysis facilities, outpatient rehabilitation facilities, comprehensive outpatient rehabilitation facilities, and community mental health centers. Data include ICD-10-CM diagnosis and procedure codes, dates of service, reimbursement amount, and beneficiary demographic information. Cause-of-injury codes are provided in some cases. The database includes

[68] https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data

more than 90 million claims for services paid under the OPPS, including multiple and single claims.

Coverage: OPPS provides claims data from 50 States and the District of Columbia. ICD-10-CM cause-of-injury codes are included for some claims. The sample population is limited to Medicare beneficiaries.

13) NATIONAL SYNDROMIC SURVEILLANCE PROGRAM (NSSP)

Source: CDC

Overview: NSSP is a collaboration among CDC, federal partners, local and state health departments, and academic and private sector partners who have formed a Community of Practice. They collect, analyze, and share electronic patient encounter data received from emergency departments, urgent and ambulatory care centers, inpatient healthcare settings, and laboratories. The public health community uses analytic tools on the platform to analyze data received as early as 24 hours after a patient's visit to a participating facility. The system captures free-text comments about the reason for the visit, discharge diagnosis codes, and demographic characteristics of the patients such as age and sex from approximately 70% of ED visits nationwide. Among all the visits reported to NSSP, which include more than 100 million ED visits annually, 74% of captured visits are reported within 24 hours, with 75% of discharge diagnoses typically added to the record within 1 week. This system allows for the syndromic surveillance of a wide variety of health exposures and outcomes.

Coverage: NSSP include data from 49 states, and the District of Columbia. More than 6,000 health care facilities contribute emergency department data to the BioSense Platform daily, with 71% of the nation's emergency departments contributing data to NSSP.

STATE DATABASES

14) STATE INPATIENT DATABASES (HCUP-SID)

Source: AHRQ

Overview: HCUP-SID consist of hospital inpatient discharge records from various State data organizations.[69] They are composed of annual, state-specific files that share a common structure and common data elements. SID contain clinical and non-clinical information (e.g., charges) on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance, and the uninsured. In addition to the core set of uniform data elements, SID include state-specific data elements or data elements available only for a limited number of States. Most data elements are coded in a uniform format across all States. Several States do not provide any public data through the HCUP

[69] http://www.hcup-us.ahrq.gov/sidoverview.jsp

Central Distributor (data for 37 States can be searched using web queries at http://hcupnet.ahrq.gov/).

Coverage: SID consist of individual inpatient discharge records from about 49 participating States. Together, SID encompass more than 97 percent of all U.S. hospital discharges. SID contain 100 percent of hospitals and patient discharges from State government and private data agencies with statewide inpatient data systems.[70] ICD-10-CM cause-of-injury codes are included for some States after 2015. Prior to 2015, ICD-9-CM codes are included. A sample of SID records is included in HCUP-NIS.

15) STATE EMERGENCY DEPARTMENT DATABASE (HCUP-SEDD)

Source: AHRQ

Overview: HCUP-SEDD are a set of databases for participating States that capture discharge information on all emergency department visits that do not result in an admission.[71] SEDD contain the emergency department encounter abstracts from participating States, translated into a uniform format to facilitate multi-state comparisons and analyses. All of the databases include abstracts from hospital-affiliated emergency department sites. The composition and completeness of data files may vary from State to State. SEDD contain a core set of clinical and non-clinical information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance, and the uninsured. In addition to the core set of uniform data elements common to all SEDD, some State data include other elements. Information on patients initially seen in the emergency department and then admitted to the hospital is included in SID. To enumerate all emergency department visits, SEDD discharges should be combined with SID discharges that originate in the emergency department.

Coverage: Data in SEDD are compiled from 42 States. SEDD contain patient-level discharge abstract data from participating States for 100 percent of discharges from hospital-affiliated emergency departments that do not result in admissions. Data include line item and summary detail for charges. ICD-10-CM cause-of-injury codes are included for many States following the 2015 update from ICD-9-CM to ICD-10-CM codes. The SEDD do not provide a nationwide database, but a sample of records is included in NEDS.

16) STATE AMBULATORY SURGERY DATABASES (HCUP-SASD)

Source: AHRQ

Overview: HCUP-SASD are a set of databases that include encounter-level data for ambulatory surgeries and may also include various types of outpatient services such as observation stays, lithotripsy, radiation therapy, imaging, chemotherapy, and labor and delivery. The specific types of ambulatory surgery and outpatient services included in

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[70] SEDD capture information on emergency department visits that do not result in an admission. SID contain information on patients initially seen in the emergency department and then admitted to the same hospital.

[71] http://www.hcup-us.ahrq.gov/seddoverview.jsp

each SASD vary by State and data year.[72] SASD contain the ambulatory surgery encounter abstracts in participating States, translated into a uniform format to facilitate multi-state comparisons. They contain a core set of clinical and non-clinical information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance, and the uninsured.

Coverage: SASD contain data from 35 States. The databases contain patient-level discharge abstract data for 100 percent of discharges from facilities in participating States. States report data for either hospital-based ambulatory surgery centers, freestanding ambulatory surgery centers, or both. ICD-10-CM cause-of-injury codes are provided for some States following the 2015 update from ICD-9-CM to ICD-10-CM codes.

17) ALL PAYER CLAIMS DATABASES (APCD)

Source: Varies by state

Overview: APCDs are large State databases that include medical claims, pharmacy claims, dental claims, and eligibility and provider files collected from private and public payers. The database does not include information on services provided to the uninsured, for denied claims, for workers' compensation claims, premiums, or capitalization fees. Unlike other statewide databases, like HCUP, these databases are maintained at the State level and are not uniform because there is no national standard. Some States have mandatory reporting requirements, while other States only voluntarily request private and public insurance providers to make this information available.

Coverage: To date, 18 States require APCDs with an additional 30 States in the process of establishing them. Florida is one State that is in the process of establishing an APCD; Minnesota is one State that maintains an active APCD. MN APCD was established by the Minnesota State Legislature in 2008. In 2014, the legislature expanded MDH's authority to use MN APCD for very specific purposes. In 2015, the legislature authorized the creation of Public Use Files (PUFs) derived from MN APCD. Currently available Public Use Files include Health Care Services, Primary Diagnoses, Health Care Utilization, Prescription Drug, Provider Specialty, and Member. The Primary Diagnoses Public Use File is the most applicable to this study.

MN APCD contains data from nearly all public and private payers in the state of Minnesota. Only companies with less than $3 million in annual medical claims and/or $300,000 in annual pharmacy claims are exempt from the data submission requirements of MN APCD. All other payers are required to submit encounter data monthly. MN APCD includes data for health care services delivered in 2008 through 2020 from more than 100 data submitters. The latest available full-year data is for 2019. It includes approximately:

- 4.11 million eligibility records per month

[72] https://www.hcup-us.ahrq.gov/sasdoverview.jsp

- 203 million medical claims
- 51 million prescription drug claims

The Primary Diagnoses PUF uses 3-digit ICD-9-CM and ICD-10-CM codes to represent the category of diagnosis for claims records. Counts of diagnoses and associated spending are based on data at the service line level associated with a given 3-digit ICD code. PUF data may significantly underestimate totals and average payments in instances where a claim service line is billed as part of a larger encounter. Additionally, records with fewer than 11 counts were redacted to prevent identification of individual members, providers, or payers.

OTHER DATABASES

18) NATIONAL TRAUMA DATA BANK (NTDB)

Source: ACSCOT

Overview: NTDB includes information on trauma patients, such as admission and discharge status, patient demographics (e.g., gender, age, race), injury and diagnosis (mechanism, e-code, ICD-10-CM or AIS code), procedure codes, injury severity scores, and outcome variables (e.g., length of stay, ICU days, payment method). The NTDB also includes the discontinued National Pediatric Trauma Registry – a multi-institutional database designed to compile information on all aspects of pediatric trauma care.

Coverage: NTDB contains over 7.5 million cases from more than 900 registered trauma centers in approximately 41 States but is not nationally representative. However, NTDB provides information for the National Sample Project, which is a nationally representative sample of 100 Level I and II trauma centers in the United States. ICD-10-CM cause-of-injury codes are included.