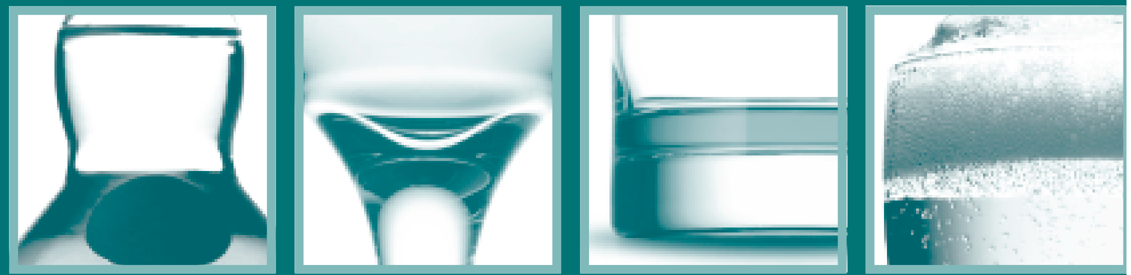
National Drug Strategy

Alcohol and Water Safety

Alcohol and Water Safety



National Alcohol Strategy 2001 to 2003-04

Occasional Paper

January 2003

Alcohol and Water Safety

Tim Driscoll
ELMATOM Ltd, Riverview, NSW

Malinda Steenkamp
James E. Harrison
Research Centre for Injury Studies
Flinders University, ,SA

January 2003

ISBN 0 642 82200 X

Publication approval number: 3193

Publications Production Unit (Governance and Business Strategy Branch)
Commonwealth Department of Health and Ageing

Contents

Executive summary

Alcohol is a major cause of mortality and morbidity in Australia, with an estimated 3,290 deaths in 1997 and 72,302 hospitalisations in 1996–97 attributable to high-risk drinking according to the National Alcohol Indicators bulletin number 1 (Chikritzhs, Jonas et al. 1999).

An objective of the *Plan for Action 2001 to 2003–04* of the National Alcohol Strategy is to reduce injuries and fatalities in the aquatic environment (Department of Health and Aged Care 2001).

This report was prepared in response to an invitation to examine the role of alcohol in drowning and other types of injury associated with recreational aquatic activities. The purpose of this report is to collate available information, including new sources, to support priority setting and policy formulation. The report specifically aimed to provide:

- A statistical description of the burden of alcohol-related drowning and near-drowning in Australia based on an attributable fractions method and published estimated fractions
- Analysis of National Coroners Information System (NCIS) data on the involvement of alcohol in drowning deaths and deaths associated with recreational boating (whether by drowning or not).
- An assessment of the potential value and feasibility of collecting data on alcohol-relatedness as part of emergency department surveillance of drowning and near-drowning cases.
- A review of literature concerning alcohol as a risk factor for drowning, near- drowning and other serious injury sustained during swimming and other water-related activities, particularly including recreational aquatic activity; and interventions against these risks.

Attributable fractions

Chapter 2 briefly reviews the main published estimates of the contribution of alcohol to drowning mortality in Australia (which constituted a limited evidence base), and then applied these estimates to the available national data on drowning mortality. The focus was the fraction of drowning deaths in the Australian population that could be attributed to alcohol.

- Death registration is generally considered to be nearly complete in Australia, and drowning is usually a well-defined cause of death. Hence, estimates of drowning mortality in Australia are probably fairly complete and reliable.
- In 2000, there were 229 deaths due to 'accidental drowning' (i.e. the Underlying Cause of Death (UCoD) were coded to ICD-10[1] external cause codes W65–W74). Another 44 deaths were coded to water transport drowning (V90 or V92), 47 to suicide by drowning (X71), 2 to homicide by drowning (X92), and 3 to drowning of undetermined intent (Y21). An additional 46 deaths were identified as related to drowning through the drowning flag available in the Australian Bureau of Statistics deaths data. 'Accidental drowning' deaths have declined from 340 in 1979 to 229 in 2000. Considering 'accidental drowning' at ages 10 years and older, rates have declined by over 40% in this period for males, but the rate for males remains more than three times the rate for females.
- A widely-used Australian assessment of drug-caused mortality and morbidity attributes about one-third of 'accidental drowning' deaths to alcohol (English, Holman et al. 1995). This was based on evidence judged by the authors to provide sufficient evidence that alcohol is a risk factor for drowning, but insufficient to quantify elevation of drowning

1 International Classification of Diseases, 10th Revision

risk in relation to alcohol level. In the absence of better information on alcohol as a risk factor for drowning, the authors selected a value of BAC (0.1 g/100ml) above which they assumed that drowning can be attributed to alcohol. The fractions of drowning cases above this threshold were obtained from six case series, one of which (studying drowning in North Carolina from 1980–1984) was the source for age-specific fractions.

- Application of the age-specific fractions from English, Holman, et al. (1995) produced an estimate of about 74 'accidental drowning' deaths in Australia per year attributable to 'hazardous or harmful' levels of alcohol consumption in the period 1997–2000 out of a total of 259 'accidental drowning' deaths per year in the same period. If the same attributable fraction is applicable to drowning deaths generally, then the total number of drowning deaths in Australia due to alcohol in this period was about 130 annually.

National Coroners Information System as an information source

The analysis in Chapter 3 is one of the first uses of the NCIS as an information source on a significant public health issue. The aim was (1) to determine how useful the NCIS is as a source of information on drowning and the possible contributory role of alcohol, and (2) to describe what available information revealed about drowning and the role of alcohol. The primary interest was all drowning deaths, but there was also a focus on deaths associated with recreational aquatic activity.

The chapter describes the structure of the NCIS and the methods used to select and report on relevant NCIS deaths occurring between 1 July 2000 and 30 June 2001. The chapter also reports on the difference between *Open* and *Closed* cases, as this has a bearing on data availability.

- A total of 282 drowning deaths was identified for the period investigated, of which 170 cases were *Closed*. Another nine non-drowning deaths related to recreational aquatic activity were identified. Nearly 80% of the deaths occurred in males and the average age was about 42 years. About 50% of all drowning deaths were related to recreational aquatic activity.
- Alcohol appeared to contribute to about 21% of drowning deaths, and perhaps 30% of drowning deaths related to recreational aquatic activity.
- The NCIS appears to already provide very useful, and in some places comprehensive, information, but still has significant shortcomings in terms of the completeness and detail of information on many cases. The availability and quality of data also varies considerably between jurisdictions.

Emergency department surveillance

Chapter 4 discusses the potential feasibility and value of collecting data on alcohol relatedness as part of emergency department (ED) surveillance of drowning and near drowning cases.

National surveillance of alcohol relatedness based on immersion cases presenting to Australian EDs is not feasible at this stage:

- There is currently no national ED data collection system and measurement and monitoring of trends in population incidence of injury via ED surveillance is difficult.
- Neither of two state-based ED data collection systems includes data items designed to identify alcohol relatedness. Barriers to ascertainment of alcohol levels among ED cases generally and at a national level are high. Special studies are more feasible.

- While some fatal immersion cases and many serious non-fatal cases present to EDs, other data sources are available. The less serious cases attending EDs are likely to be a small proportion of all such cases, and may not be representative.

Literature review

Chapter 5 presents a brief literature review on what is known about drowning, near drowning and other injuries arising from recreational aquatic activities, together with a review of what is known about alcohol's contribution to these cases. The main focus was recreational aquatic activities.

- Evidence from North America suggests that alcohol is widely used in association with recreational aquatic activity, although there is no information regarding the extent of use in Australia. *A priori* and anecdotal evidence suggests alcohol is an important risk factor for death and serious injury arising from recreational aquatic activity.
- The extent of increased risk associated with alcohol use, and the attributable risk due to alcohol use, is not well characterised.
- The few relevant studies on the degree of increased risk suggest that persons with a blood alcohol level of 0.10g/100ml have about 11 times the risk of death associated with recreational boating compared with persons who have not been drinking, and that even small amounts of alcohol can increase this risk. The population attributable risk seems to be in the range of about 10%–30%.
- Alcohol is detected in the blood of about 30% to 50% of fatally injured persons involved in recreational aquatic activity.
- There is very little information on the role of alcohol in recreational aquatic activity, and serious and fatal injury associated with recreational aquatic activity, in Australia.

Many prevention activities have been suggested in the literature, as well as areas for further work. The main areas from an Australian perspective where further work is needed appear to be:

- determining the extent of alcohol use in Australia in relation to recreational aquatic activity;
- obtaining information on the knowledge, attitudes and behaviours of Australians in relation to alcohol use and aquatic activity;
- determining the extent of increased risk of serious and fatal injury in association with recreational aquatic activity in Australia; and
- evaluation of current and proposed interventions to reduce the contribution of alcohol to serious and fatal recreational aquatic activity.

Summary and conclusions

(i) Reliable identification of deaths by drowning

Information obtainable from current information sources appears to be sufficient to enable adequately reliable identification of deaths by drowning in Australia. Timeliness is the attribute most warranting improvement.

RECOMMENDATIONS:

Continue to use ABS mortality data as the basis for monitoring drowning mortality. Supplement this with NCIS because of the additional case information which it provides. Continue to assess NCIS for other benefits, with particular reference to timeliness and to data on Queensland deaths (when available).

(ii) Reliable information on alcohol intoxication by people who have died by drowning in Australia.

Estimation based on published attributable fractions has been the best available basis for estimating alcohol-related drowning mortality in Australia. The NCIS appears to provide a better basis for assessing and monitoring alcohol-relatedness of drowning deaths in Australia than the published attributable fractions. Its value for this purpose will be confirmed when data become available for Queensland. Its value will be enhanced by speedier closure of cases (or release of blood alcohol data prior to closure) and by inclusion in NCIS case records of Underlying Cause of Death codes, as determined by the ABS. Our analysis of initial NCIS data suggests that the fraction of drowning deaths in Australia attributable to alcohol is lower than that proposed by English et al. in all age groups, especially at ages 60 years and older.

The ABS drugs flag item could become more useful for this purpose if the criteria for flagging 'alcohol-relatedness' were specified, and if the flag included a value meaning 'a test for alcohol was done and none was found' (or that the result was below a chosen criterion, such as 0.10 g/100/ml), and a value meaning 'BAC not assessed' or 'no information'.

RECOMMENDATIONS:

- ***Use NCIS data to derive future estimates of relevant alcohol use among people who have drowned in Australia.***
- ***Re-analyse NCIS data periodically (e.g. annually) to monitor presence and levels of alcohol among drowning deaths.***
- ***Advocate liaison between ABS and the operators of the NCIS with a view to developing the 'drug flag' so that it becomes interpretable as an indicator of BAC at death.***
- ***Advise the Monash University National Centre for Coronial Information (MUNCCI) of the usefulness of the NCIS data for this project. Also inform MUNCCI of the project officers' recommendation that a mechanism should be developed to enable data corrections made during a project such as this to be applied (after appropriate checking) to the main NCIS data collection.***

(iii) Evidence of the relationship between alcohol use and risk of drowning based on analytic studies.

Current information provides an adequate basis for concluding that alcohol intoxication increases the risk of drowning during aquatic activities. However, it is not adequate to provide robust information concerning the shape of the relationship (including thresholds), nor about possible variation in the relationship between settings and types of aquatic activities.

RECOMMENDATIONS:

Advocate that one or a small number of analytic studies should be undertaken, preferably in Australia, to provide confirmatory and more specific evidence of the relationship between BAC and risk of drowning (or of adverse consequences of aquatic activities more broadly). Existing studies provide relevant examples (Smith and Houser 1994; Smith, Keyl et al. 2001).

(iv) Reliable and recent information on patterns of alcohol use among people exposed to risk of drowning in Australia.

Information about the use of alcohol in the context of aquatic activities in Australia is inadequate both for reliable estimation of the proportion of drowning attributable to alcohol, or to provide a basis for information-based policy response (e.g. monitoring effects of programs to discourage drinking before swimming or while boating).

RECOMMENDATIONS:

Undertake or advocate for studies of alcohol use in the context of aquatic activities. The studies should seek information on knowledge and attitudes concerning alcohol use and risks, as well as information about its use.

(v) Detailed information characterising people, places and events associated with drowning in ways likely to provide insights relevant to prevention.

The NCIS is a rich new source of information, which can be used to characterise as well as to quantify deaths due to external causes, including alcohol-related drowning. It differs in some ways from other sources, and learning how to make the most of its potential requires experience. Special studies can provide a more complete understanding to guide effective reduction of alcohol-related harm during aquatic activities.

RECOMMENDATIONS:

Continue to test and use the NCIS concerning alcohol and water safety, and other issues concerning drugs and alcohol. Advocate for special studies, including one or more case-control studies, and surveys of alcohol use, knowledge and attitudes in the context of aquatic activities.

Australian National Alcohol Strategy

The *Actions* and *Outputs* stated in the Australian National Alcohol Strategy concerning alcohol related harm associated with aquatic activities are consistent with prevention activities suggested in the published literature and with other findings of this project. The only additional *Action* recommended here is for one advocating evaluation of interventions.

Acknowledgments

Thank you to Stacey Wendt for obtaining many of the references used in the literature review and to Jessica Pearce (from Monash University National Centre for Coronial Information) for supplying NCIS data.

1 Introduction

Alcohol is a major cause of mortality and morbidity in Australia, with an estimated 3,290 deaths in 1997 and 72,302 hospitalisations in 1996–97 attributable to high-risk drinking according to the National Alcohol Indicators bulletin number 1 (Chikritzhs, Jonas et al. 1999).

Over 400 drowning deaths per year have occurred in Australia in recent years. Drowning and near drowning is one of the four Priority Areas for 2001–2003 specified in the National Injury Prevention Plan and the associated Implementation Plan (Department of Health and Aged Care 2001).

Alcohol is widely recognised as being a major risk factor for injury, and injury is an important form of harm attributable to alcohol (Department of Health and Aged Care 2001). Recognition of the role of alcohol as a risk factor for drowning, near drowning and other types of injury associated with water-related activities is increasing (Smith, Keyl et al. 2001). The National Alcohol Strategy states that it is important that the community is 'aware of the specific risks involved in misuse of alcohol around water'. However, information of sufficient specificity to guide priority setting and program design in Australia is lacking.

This report was prepared in response to an invitation to examine the role of alcohol in drowning, particularly with regard to recreational aquatic activities, and to include consideration of the role of alcohol in other types of injury associated with recreational aquatic activities. The purpose of this report is to collate available information, including new sources, to support priority setting and policy formulation. The report specifically aimed to provide:

- A statistical description of the burden of alcohol-related drowning and near-drowning in Australia based on an attributable fractions method and published estimated fractions;
- Analysis of National Coroners Information System data on the involvement of alcohol in drowning deaths and deaths associated with recreational boating (whether by drowning or not);
- An assessment of the potential value and feasibility of collecting data on alcohol-relatedness as part of emergency department surveillance of drowning and near-drowning cases; and
- A review of literature concerning alcohol as a risk factor for drowning, near- drowning and other serious injury sustained during swimming and other water-related activities, particularly including recreational boating; and interventions against these risks.

Chapter 2 presents a statistical description of the burden of alcohol-related drowning in Australia based on an attributable fractions method and published estimated fractions.

An analysis of National Coroners' Information System (NCIS) data on the involvement of alcohol in drowning deaths in general, and specifically deaths associated with recreational aquatic activity (whether by drowning or not) is reported in Chapter 3.

Chapter 4 gives an assessment of the potential value and feasibility of collecting data on alcohol relatedness as part of emergency department (ED) surveillance of drowning and near drowning cases.

Chapter 5 contains a review of literature concerning alcohol as a risk factor for drowning, near drowning and other serious injury sustained during swimming and other recreational aquatic activities, particularly including recreational boating; and interventions against these risks.

A summary of findings, and conclusions and recommendations based on these, are presented in Chapter 6.

2

2 Attributable fractions

Introduction

This chapter provides a context for the literature review (Chapter 5) and the analysis of Australian Coroners' data (Chapter 3). It does so by briefly reviewing the main published estimates of the contribution of alcohol to drowning mortality in Australia, and by then applying these estimates to the available national data on drowning mortality.

Key Terms

The focus here is the fraction of drowning deaths (or of other specified outcomes) in the Australian population that can be attributed to alcohol.

Usage of terminology relevant to this issue is somewhat variable. To minimise potential confusion, the definitions in Last's Dictionary of Epidemiology 4th edition have been followed (Last 2001). The following definitions are from that source:

> ***Attributable Fraction: The proportion of all cases that can be attributed to a particular exposure. It is the attributable difference (attributable risk) divided by the incidence rate in the group. If the association is causal, this is also the proportion by which the incidence rate would be reduced if the exposure were eliminated. The attributable fraction may apply to individuals (ATTRIBUTABLE FRACTION (EXPOSED) or to the whole population (ATTRIBUTABLE FRACTION (POPULATION).***
>
> ***Attributable Fraction (population): With a given outcome, exposure factor and population, the attributable fraction among the population is the proportion by which the incidence rate of the outcome in the entire population would be reduced if exposure were eliminated.***

Etiologic (or *aetiologic*) *fraction* is a synonym for *attributable fraction (population).*

Ideally, attributable fractions would be specific for age, sex, and particular types of cases of interest (e.g. drowning while recreational fishing in small boats). In practice, however, the specificity of attributable fractions is limited by the extent of relevant scientific literature.

Structure of the chapter

The following section summarises published Australian estimates of fractions of drowning attributable to alcohol. (No Australian attributable fractions for alcohol and near drowning were found.) The section after next summarises data on drowning mortality in Australia. This is followed by a section in which the available attributable fractions are applied to the drowning mortality data to obtain estimates of numbers and rates of drowning deaths that are attributable to alcohol.

Existing estimates of the fraction of drowning in Australia attributable to alcohol

Three reports have been published since 1988 with the title *The quantification of drug-caused morbidity and mortality in Australia* (Holman and Armstrong 1990; Holman, Armstrong et al.

1990; English, Holman et al. 1995). A revised summary of the first dealt only with mortality (Ridolfo and Stevenson 2001). Findings and analysis of these four reports concerning alcohol as a cause of drowning are summarised in Table 2.1.

Table 2.1: Drowning data in studies of drug-caused morbidity and mortality, Australia

Report	Definition	Evidence base	Summary of evidence
Holman et al. (1990) (pp 159–162)	UCoD = ICD-9 E910	1 case-control study (Waller 1972) 5 case series 1 clinical survey	Pooled estimates of 'any alcohol' among drowning cases: M 55% F 9%. Estimate of relative effect (any positive BAC): 1.89 (0.64–5.55) Attributable fractions (any positive BAC): **Males Females** Exposed 0.47 0.47 General population 0.26 0.04
Holman and Armstrong (1990) (pp 8– 9, 13–14)	UCoD = ICD-9 E910	As above. Also comparison of Holman et al. (1990) values with those based on an earlier method (Drew 1982)	Age-specific population attributable fractions (age groups in years) **0–14 15–34 35–64 65+** Males – 0.26 0.26 0.26 Females – 0.04 0.04 0.04 'Old' and 'New' methods (ages 15 and older) **Males Females** Old (Drew, 1982) 0.30 0.30 New (Holman & Armstrong, 1990) 0.26 0.04
English et al. (1995) (pp 215–217)	UCoD = ICD-9 E910	8 case series, 6 of which were pooled.	Pooled estimate for males and females of proportion of drowning cases with BAC >0.1g/100ml (based on 6 case series weighted by study size): 0.35 One of the 6 series which were pooled by English et al. reported an all-ages proportion very close to the pooled estimate and provided age-specific values (Centers for Disease Control and Prevention 1986) The age-specific values presented by English et al. were taken from this single case series. General population attributable fractions: **10–14 15–29 30–44 45–59 60+** Males 0.03 0.32 0.50 0.42 0.31 Females 0.03 0.32 0.50 0.42 0.31 Conclusions by authors: • There is *sufficient evidence* that alcohol causes drowning. • All drowning cases attributed to alcohol are due to *hazardous or harmful* level of consumption.
Ridolfo (2001) (pp 45, 113, 115)		No literature assessment	Comment on English et al. (1995): '…in the absence of better or more recent data, we used the same value.'

This amounts to a limited evidence base. Only one study providing an estimate of relative effect is reported (Waller 1972), and it is only cited in the first of the four reports. The age-specific attributable fractions presented in English et al. (1995) are based on a single report of drowning mortality in one state of the USA in the early 1980s. These fractions are not gender-specific, though the pooled estimate in Holman et al. (1990) suggests marked differences between males and females. The second conclusion of English et al. (1995), i.e. that all drowning cases attributed to alcohol are due to 'hazardous or harmful' levels of consumption, is clearly an approximation, and appears to be based on little specific evidence.

All of the reports in the series *The quantification of drug-caused morbidity and mortality in Australia* define 'drowning' as deaths for which the Underlying Cause of Death (UCoD) was given an International Classification of Diseases, ninth revision (ICD-9) code of E910

(*Accidental drowning and submersion*)[2] . However, about one-third of identifiable drowning deaths in Australia fall outside of this definition (Table 2.2).

Data on drowning in Australia

The principal source of routine information on causes of death in Australia is the mortality data collection produced by the Australian Bureau of Statistics (ABS). This source is described elsewhere, focusing on characteristics that are relevant to injury surveillance. (Harrison, Miller et al. 2001; Harrison and Steenkamp 2002).

In short, all or almost all deaths in which drowning is known or suspected to have occurred are required, by law, to be referred to a coroner. The coroner is responsible for determining certain matters about a death, one of which is its pathological cause. The nature and extent of the inquiries undertaken for this purpose vary greatly from case to case. The usual outcome of the process is a formal written *Finding* by the coroner, which normally includes a conclusion about the cause or causes of death. This information (or part of it) is recorded as the cause of death in the Register of Births Deaths & Marriages in the State or Territory in which the death occurred. It is also provided to the ABS, which uses the information as the basis for producing cause of death codes.

The short name of the coding system used by the ABS for this purpose is the International Classification of Diseases (ICD), versions of which have been used to code deaths in all developed countries for many years (almost a century in Australia). The ninth Revision of ICD (ICD-9) was used to code deaths registered in Australia from 1979–1998, inclusive, after which it was replaced by the tenth revision (ICD-10). The ABS has also coded deaths registered in 1997 and 1998 according to ICD-10, providing a basis for assessing some effects of the change from ICD-9 to ICD-10. (In this section, we have used the ICD-10 coded version of the data for the ‘overlap’ years 1997 and 1998.)

Table 2.2 summarises all deaths registered in Australia from 1979–2000 that can be identified as involving drowning on the basis of information in the standard mortality data files produced by the ABS.

Two changes to this data source, which occurred in the period tabulated, are noteworthy because they improved the potential to identify from among all registered deaths the ones in which drowning occurred. The first change was the introduction of a special data item to flag deaths involving drowning. The second was the provision of information on ‘multiple causes of death’. These two changes divide the period shown in Table 2.2 into three sub-periods, in which different information was available, as described below.

1979–1991: ‘Underlying Cause of Death’ only

Until 1991, the only basis for identifying ‘drowning’ deaths in the national mortality data collection was the single data field ‘Underlying Cause of Death’ (UCoD), which, at that time, was coded according to ICD-9. Rules associated with the ICD were applied by the ABS to decide which of the causes of death that are mentioned in sources available to them was recorded as the ‘underlying’ cause.

Several ICD-9 codes were available to record drowning as an UCoD. All of the relevant codes are in the ICD-9 chapter ‘External Causes of Injury and Poisoning’. These codes are represented by the columns in Table 2.2 numbered 1 (Accidental drowning), 2 (Water transport), 3 (Suicide),

2 The ICD-10 external cause codes with scope equivalent to ICD-9 E910 are W65–W74.

4 (Homicide) and 5 (Undetermined intent). The ICD code equivalents to these categories are stated in footnotes to the table.

Note that reports on injury mortality, or mortality more generally, quite often allow only the first of these groups of drowning deaths to be distinguished, the other potentially identifiable drowning deaths being included with transport mortality, suicide, and so on. The usual name for this group ('Accidental Drowning') has been retained for consistency with this common practice. However, all of the cases in column 2 of Table 2.2, and some of those in columns 6 and 7, could also be put under this name (or a similar name, such as 'unintentional drowning').

1992–1996: 'Underlying Cause of Death' and the 'Drowning' flag item

Many deaths, including deaths by drowning, can be attributed to more than one cause. If drowning is mentioned in the case information, the ICD-based rules for selecting an UCoD usually, but not always, result in drowning being recorded as the UCoD. Common exceptions are death by drowning following a road crash (the rules for selecting Underlying Cause give priority to road crashes over drowning), suicide involving drugs and immersion, and drowning due to an epileptic seizure.

During 1991, the ABS began using a special new data item to 'flag' deaths that, according to source information, involved drowning. The 'flag' could be used to identify drowning deaths even if application of the ICD coding rules resulted in an UCoD code that did not mention drowning. The item was used for deaths registered in some States in 1991, and nationally from 1992. (This item also codes some additional information about the circumstances in which drowning deaths occurred.)

The effect of this new item can be seen in column 6 of Table 2.2. Deaths in this column have Underlying Cause codes that refer to external causes, but make no mention of drowning. Considering deaths registered in the years 1992–1996, the drowning flag item increased the number of 'external causes' deaths identifiable as involving drowning by about 9%.

From 1997: UCoD, multiple causes, and Drowning flag

Beginning with deaths registered during 1997, the data file released by the ABS includes fields for codes to represent up to twelve causes for each death. (The number of fields was later increased to twenty.) Relevant data in these 'multiple cause' fields can include any of the external cause codes which refer to drowning, or a code representing 'drowning and non-fatal submersion' (ICD-10 code T75.1) as an injury or other consequence of an external cause.

The data shown in columns 6 and 7 of Table 2.2 for the years 1997–2000 include drowning deaths identified on this basis, or by use of the drowning flag item. Note that the UCoD of the cases shown in column 7 was not an 'external cause'. (The UCoD recorded for almost three-quarters of these 65 deaths was epilepsy.)

The information on multiple causes of death (MCoD) added relatively few deaths involving drowning to the number identifiable on the basis of 'underlying cause' codes and the Drowning flag. Considering the years 1997–2000, cases solely identifiable by means of 'multiple cause' data increased the total number of identifiable drowning deaths by about 0.9%.

Table 2.2: Identifiable drowning deaths, Australia 1979–2000: case counts for persons

	Drowning identified by 'Underlying Cause of Death' codes					Other drowning	
Year of death registration	1 Accidental drowning [(a)]	2 Water transport drowning[(b)]	3 Suicide by drowning[(c)]	4 Homicide by drowning[(d)]	5 Drowning, undetermined intent[(e)]	6 Non-drowning external cause[(f)]	7 Not external cause[(g)]
1979	340	85	63	0	18	—	—
1980	341	90	54	4	21	—	—
1981	334	68	75	3	13	—	—
1982	320	62	72	3	13	—	—
1983	328	95	74	8	7	—	—
1984	272	68	76	3	11	—	—
1985	294	85	66	3	14	—	—
1986	269	56	75	10	20	—	—
1987	293	68	76	6	29	—	—
1988	302	59	65	5	20	—	—
1989	314	50	61	4	17	—	—
1990	300	74	49	8	23	—	—
1991	269	72	56	6	27	17	—
1992	291	61	72	3	27	30	—
1993	288	56	76	11	18	24	—
1994	250	53	59	2	8	41	—
1995	259	56	71	5	8	34	—
1996	247	47	47	1	15	63	—
1997	279	44	73	7	11	23	19
1998	249	27	50	3	8	46	16
1999	278	48	37	3	5	43	16
2000	229	44	47	2	3	32	14

(a) ICD-9 E910 to 1996; ICD-10 W65–W74 from 1997

(b) ICD-9 E830 or E832 to 1996; ICD-10 V90 or V92 from 1997

(c) ICD-9 E954 to 1996; ICD-10 X71 from 1997

(d) ICD-9 E964 to 1996; ICD-10 X92 from 1997

(e) ICD-9 E984 to 1996; ICD-10 Y21 from 1997

(f) Deaths where UCoD was an external cause category that does not mention drowning and the special flag item indicates 'Drowning'. The flag item was used for 1991 deaths in some States and nationally from 1992.

(g) Deaths where UCoD was not an external cause and the flag item or Multiple Cause of Death items indicate drowning.

— Not applicable as data were not available for these cases for these years.

Considered in terms of case numbers (rates are shown later) the data in Table 2.2 suggest that drowning has declined as a cause of death in Australia. Columns 1–5 should be comparable for the whole period shown. The total of these columns in each of the first five years tabulated was about 500 deaths. In four of the last five years shown, the total was well under 400 deaths.

The data for the last four years in the table are based on the broadest criteria for case inclusion. Total case numbers (i.e. columns 1–7) varied quite a lot from year to year, from 456 in 1997 to 371 in 2000.

Death rates due to drowning are summarised in Figure 2.1. Rates are shown separately for males and females, and for 'drowning' according to four definitions.[3] The values are annual average rates for the four years 1997–2000. All-ages rates of drowning were three to four times higher for males than for females.

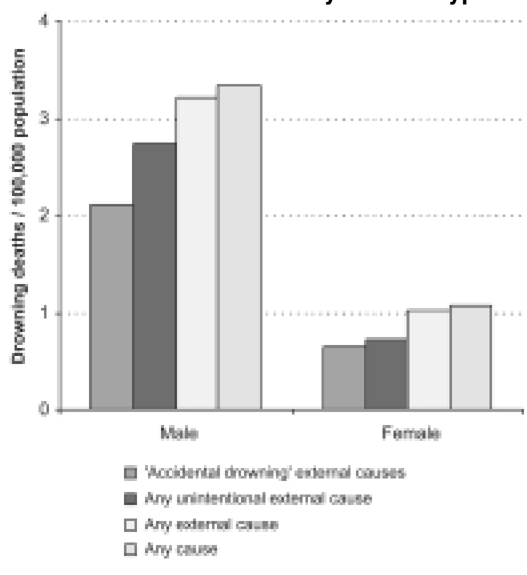
The columns showing the lowest rate for each gender group (i.e. 'Accidental drowning' external causes) are based on the same case definition of 'drowning' as are the attributable fractions reported by English et al. (1995).

Figure 2.2 shows age-specific rates of drowning for the same four case definitions as are shown in Figure 2.1. The rates are for persons.

Drowning rates in Australia were highest for very young children, and almost all of the cases in this age group were in the 'Accidental Drowning' category. Rates were lowest for older children.

The rate of 'Accidental Drowning' did not vary much with age from the 15–19 year age group to the oldest group (about 1.0 to 1.5 deaths per 100,000 population per year). The pattern was similar, though at a higher level, for the group of cases including all unintentional drowning deaths. In contrast, the rate of drowning including other external causes (mainly suicide) tended to be higher at older ages.

Figure 2.1: Deaths identified as involving drowning registered in Australia 1997–2000: rates by sex and type of Underlying Cause of Death



3 The first definition is equivalent to column 1 in Table 2.2, the third to columns 1– 6, and the fourth to columns 1–7. The second category in Figure 2.1, 'Any unintentional external cause' is equivalent to columns 1 and 2 in Table 2.2, plus cases in column 6 for which the UCoD is in the ICD-9 range E800–E929, or the ICD-10 range V00–X59.

Trends in drowning rates from 1979–2000 are shown in Figure 2.3 for two age groups: less than five years, and all older ages. Drowning rates declined for both of these age groups in the period shown. In terms of absolute values, rates declined much more for the young group than for older ages. Considered in terms of percentage change, the decline was similar for both groups in the first half of the period, and more pronounced for the young group than the older group in the second half.

Figure 2.2: Deaths identified as involving drowning registered in Australia 1997–2000: rates by age group and type of Underlying Cause of Death

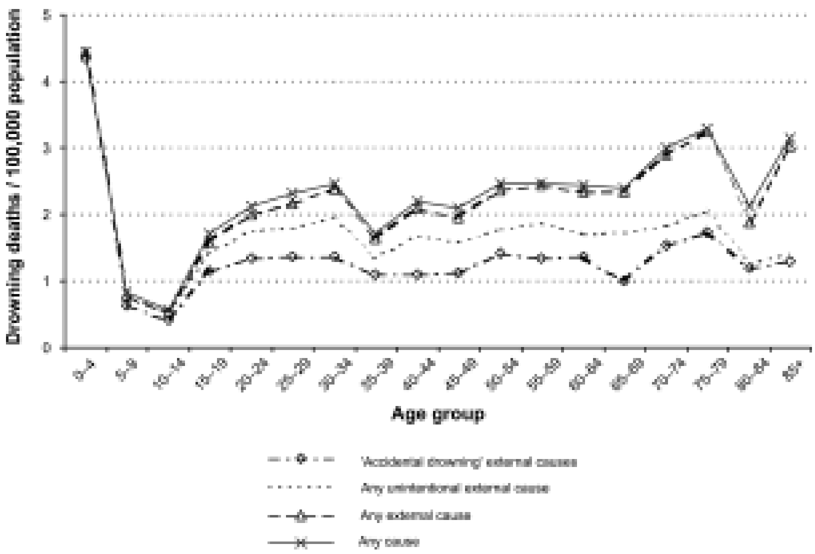


Figure 2.3: 'Accidental drowning' deaths (E910 and W65–W74) by year of death registration, Australia 1979–2000: age-specific rates at ages 0–4 years and age- and sex-adjusted rates for ages 5 years and older

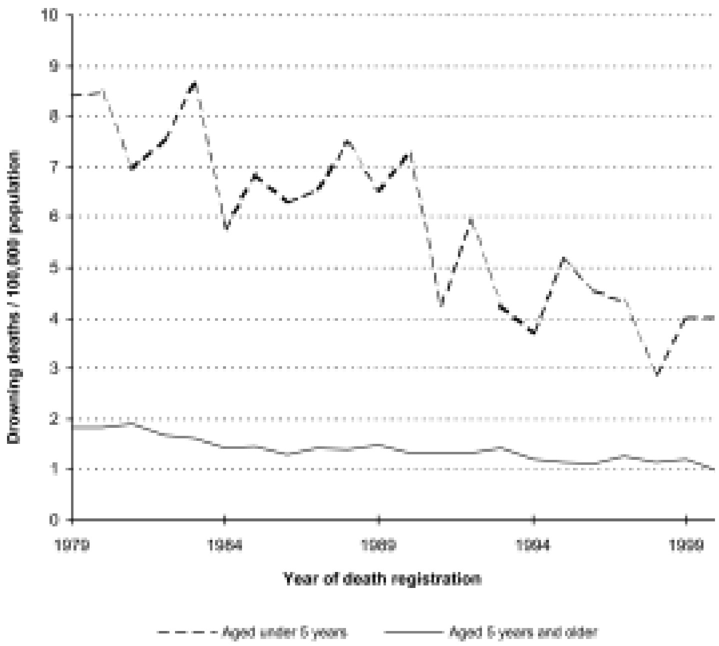
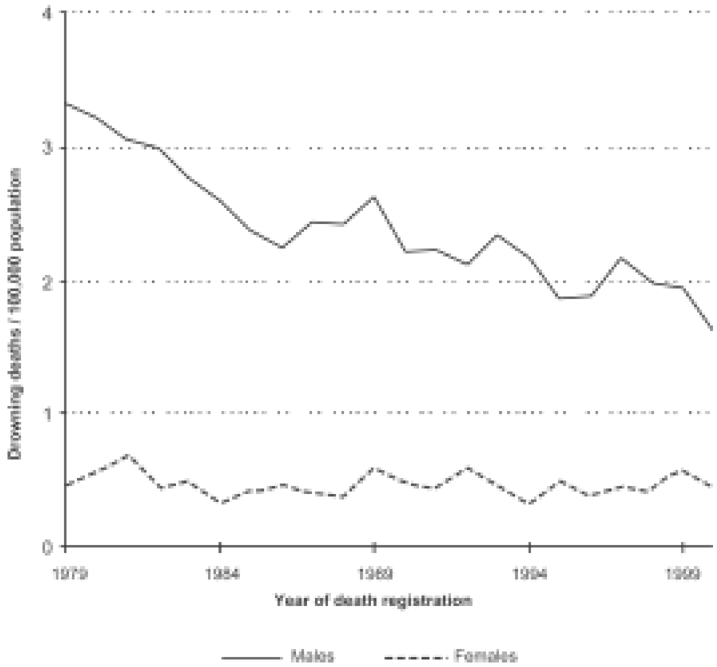


Figure 2.4: 'Accidental drowning' deaths (E910 and W65–W74) at ages 10 years or older by year of death registration, Australia 1979–2000: age-adjusted rates by sex



The fractions of drowning deaths attributed to alcohol according to the values provided by English et al. (1995) are zero for ages 0–9 years[4], and various non-zero fractions at older ages (see Table 2.1). Figure 2.4 shows trends in age-adjusted rates of 'Accidental drowning' in Australia at ages 10 years and older, by sex.

Rates for males aged 10 years or older declined by about one-half during the 22 year period shown. Equivalent rates for females, although much lower than male rates throughout the period, did not decline.

Applying existing attributable fractions to data on drowning in Australia

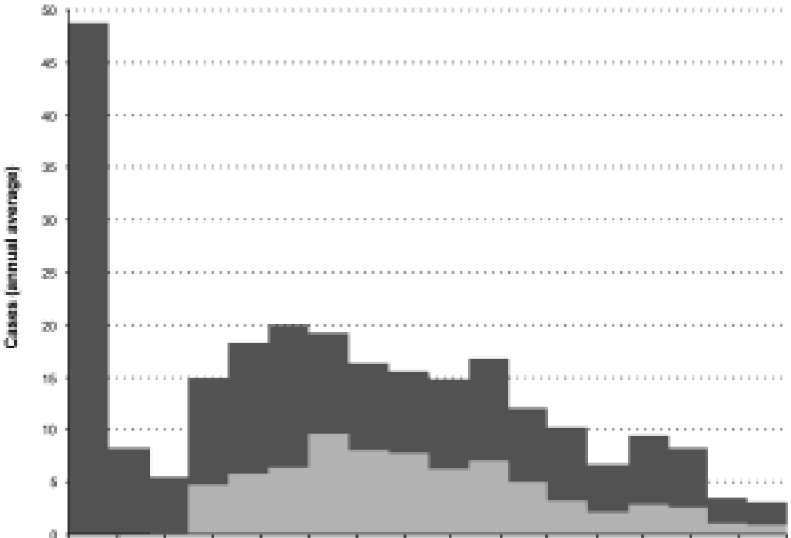
This section presents estimates of drowning mortality in Australia attributable to alcohol, based on the attributable fractions (population) and drowning case numbers presented in the two previous sections.

In particular, the all-ages and age-specific estimates presented in English et al. (1995) have been applied to Australian mortality data for the period 1979–2000.

These attributable fractions were applied to 'Accidental drowning' according to the definition used by the reports mentioned in Table 2.1, i.e. cases where UCoD = ICD-9 code E910 or ICD-10 codes W65–W74 (Figure 2.1).

4 This is an approximation, and is based on data limited to an assessment of alcohol levels in persons who drowned. It could be the case that consumption of alcohol by adult care-givers contributes to some deaths by drowning of young children.

Figure 2.5: Annual average number of 'Accidental drowning' deaths (W65–W74) by age group, Australia 1997–2000: all drowning deaths and the sub-group of cases attributed to alcohol using the fractions from English et al. (1995)



	0-4	5-9	10-14	20-24	25-29	30-34	35-39	40-44	50-54	55-59	60-64	65-69	70-74	80-84	85
All drowning deaths	49	8	6	18	20	19	16	16	17	12	10	7	10	4	3
Alcohol attributable	0	0	5	6	6	10	8	8	7	5	3	2	3	1	1

Age group

Some results of this are shown in Figure 2.5 as age-specific numbers of all 'Accidental drowning' deaths, overlayed by the number of these deaths that are attributed to alcohol, according to the fractions in English et al. (1995). The values are average annual case numbers for the four-year period 1997–2000.

The shorter bars in Figure 2.5 show the number of 'Accidental Drowning' deaths (i.e. deaths given a cause code W65–W74) in each age group that are attributed to alcohol, according to the fractions published by English et al. (1995).

As described above, 'Accidental Drowning' is a commonly reported category of cases, but it does not include all identifiable deaths from drowning. Figures 2.1 and 2.2 show drowning death rates according to each of four, increasingly more inclusive, case definitions.

Table 2.3 shows numbers of alcohol-attributable deaths calculated when the English et al. (1995) attributable fractions are applied to the numbers of deaths included by each of these four case definitions. Note that the column values in this table are cumulative – that is, each column includes the same cases as the column to its left, plus additional cases meeting its wider case definition.

This is intended only as an indicative exercise, as English et al. (1995) made no claim that the attributable fractions that they presented are applicable to drowning cases other than those for which UCoD is E910 (or, by implication, in the range of ICD-10 codes with equivalent scope, W65–W74).

The age-specific fractions were applied and the resulting estimates of age-specific numbers of drowning deaths summed to produce all-ages estimates. The last two rows in Table 2.3 show the effect of applying the 'all ages' attributable fraction supplied by English et al. (1995). In the first of these rows, the all ages fraction (which is 0.34) is applied to drowning cases at any age. In the final row, the same fraction is applied to drowning deaths at ages 10 years and older, the age range for which fractions are non-zero in the age-specific set.

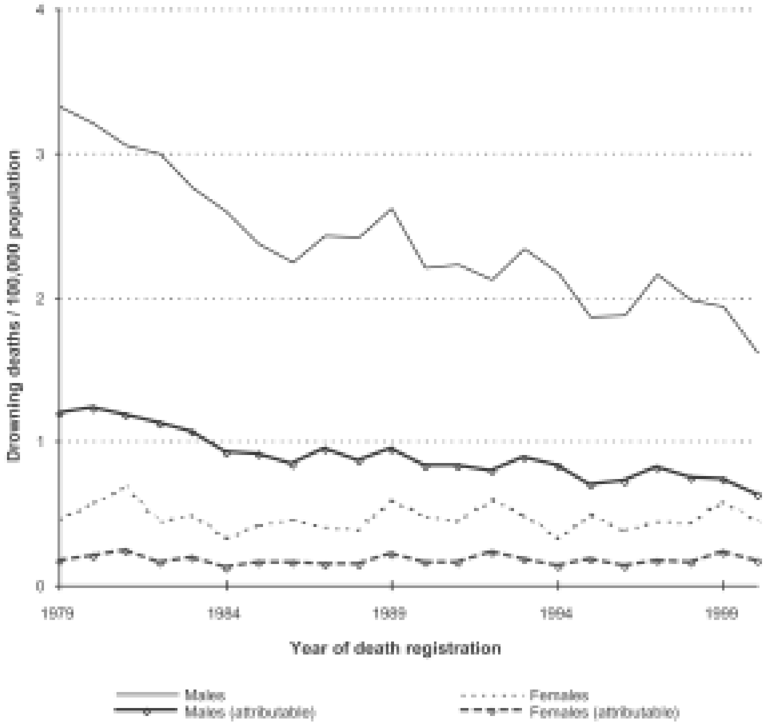
Table 2.3: Drowning deaths by age group and type of Underlying Cause of Death, Australia 1997–2000: annual average cases attributed to alcohol using fractions from English et al. (1995)

AGE	'Underlying Cause of Death'			
	'Accidental drowning' external causes	Any unintentional external cause	Any external cause	Any cause
0–4	0	0	0	0
5–9	0	0	0	0
10–14	0	0	0	0
15–19	5	6	7	7
20–24	6	8	9	9
25–29	6	8	10	11
30–34	10	14	17	18
35–39	8	10	12	13
40–44	8	12	15	16
45–49	6	9	11	12
50–54	7	9	12	12
55–59	5	7	9	9
60–64	3	4	5	6
65–69	2	4	5	5
70–74	3	3	6	6
75–79	3	3	5	5
80–84	1	1	2	2
85 plus	1	1	2	2
Sum of age specific counts	**74**	**99**	**126**	**132**
Constant fraction (0.34)				
Applied to all ages	86	108	133	138
Applied to ages 10 and older	66	88	112	117

Finally in this section, consideration is made of how rates of 'Accidental drowning' deaths attributed to alcohol according to the fractions from English et al. (1995) varied over time and differed for males and females (Figure 2.6).

Note that the alcohol-attributed rates shown in this figure are based on application of the same age-specific attributable fractions throughout the period. Even if these fractions were a good approximation of reality for one part of the period, this need not have been so for the whole period shown.

Figure 2.6: 'Accidental drowning' deaths (E910 and W65–W74) by year of death registration, Australia 1979–2000: age-adjusted rates of all cases and of cases attributed to alcohol using age-specific fractions from English et al. (1995)



3 The National Coroners Information System as an information source

Introduction

The National Coroners Information System (NCIS)[5] is a national system of information and supporting infrastructure that is designed to provide prompt access to coronial data from all coronial jurisdictions in Australia, to support the work of coroners and others interested in the prevention of injury and disease. The NCIS has been developed for coroners, and is managed, by the Monash University Centre for Coronial Information (MUNCCI).

At the time of writing, the NCIS covered all Australian States and Territories, with Queensland data recently being entered into the system but not yet being publicly accessible. All deaths referred to a coroner and that occurred in Australia (except Queensland) from 1 July 2000 onwards are supposed to be entered into the system.

Although the NCIS has been established partly as a source of information to support the prevention of injury and disease, its effectiveness in this role has not yet been tested through the practical use of the data. Like any such system, teething problems can be expected early in its operation, so it is important to use the data in order to identify the strengths and limitations of the system.

This section of the project had two interests or themes in relation to the NCIS:

- to determine how useful the system is as a source of information on drowning and the possible contributory role of alcohol; and
- to determine what the available information revealed about drowning and the role of alcohol.

The primary interest was all drowning deaths, but there was also specific interest in deaths associated with recreational aquatic injury, including non-drowning deaths (if any).

Structure of the NCIS

The structure of the NCIS is well described in several MUNCCI publications, one of which is quoted here. ‘The NCIS has been designed to hold Core Data Items that are fields, variables or reports concerning the deceased person, the causes and circumstances of death and related matters. Depending on the data item, this information is in the form of codes (or code labels); numerical values (e.g. for age); brief passages of text (e.g. for name and address) or documents. Much of this information is recorded as an ordinary part of the practice of coroners and their staff. Several core data items (e.g. Mechanism of injury) are designed to enable users of NCIS data to identify specific types of cases efficiently and reliably. The coroners’ findings are generally in the form of text files’ (this description is taken from the NCIS Data Dictionary (MUNCCI, 2001)).

Information is entered at various stages of the coronial process. The initial data entry involves notification of the case to the system. The final data entry should occur at the time the case is closed. Because the available information changes during the coronial investigation process, assessments of the surrounding circumstances may change over time. Therefore, for several

5 Information about the NCIS is available at: http://www.vifp.monash.edu.au/ncis/

important data concepts, relevant data items are coded separately at the time of case notification and again at the time of case closure.

Most of the categorical variables are coded and entered at individual State and Territory coroners' offices. Text documents are prepared or compiled as part of the coroner's investigation process or at the conclusion of the case. The most relevant data items for the current project are considered here.

Closed and *Open* cases

One of the most important data elements from a research point of view is the Case status data element, which describes whether the case is *Open* or *Closed*. *Closed* cases are those for which the coronial process has been completed and for which all required information has been entered into the NCIS. *Open* cases are those that are either not finalised by the coroner, or that are finalised but for which the required information has not been entered into the NCIS database. Detailed and identifying information is available to third party users of the NCIS only for *Closed* cases. This means that documents such as the police report, autopsy report, toxicology report and finding are not available for *Open* cases. This clearly limits the usefulness of the available coded information for *Open* cases, because there is no way of verifying the information or properly understanding the circumstances surrounding the fatal injury. Information is sometimes added to NCIS records after they have been given *Closed* status.

Case Type

The Case Type is classified at the time of notification and again when the Coronial process is completed. Deaths are classified as 'Natural Cause' deaths (those due to 'illness'), 'External Cause' deaths (those due to 'injury'), and deaths for which the case type is not known. The deaths of interest in this study were expected to be classified as External Cause deaths.

Intent

Like Case Type, Intent is classified at the time of notification and the time of case completion (i.e. the time the case is *Closed*). The main categories of this data element relevant for this project were 'Unintentional', 'Interpersonal violence', 'Intentional self-harm' and 'Unlikely to be known'. Deaths due to drowning could be expected to be coded to any of these categories. Deaths arising from recreational aquatic activity would be expected to virtually all be classified as unintentional.

Mechanism

The 'Mechanism' data element is defined as 'The way in which injury was sustained. How the person was hurt.' (NCIS Data Dictionary, Version 1, p 95). Up to three Mechanisms can be coded for any one incident, with a text field available for each of these. This data element should identify all deaths that are due to drowning, but does not indicate the activity of the person at the time of fatal injury. On the basis of published literature, a considerable proportion of people who drown can be expected to have been involved in recreational aquatic activity at the time, and a large proportion of people who die as a result of recreational aquatic activity drown.

Object or substance producing injury *(see Appendix 8.1)*

Up to three objects can be coded, with a text field allocated for each. A small number of objects could be expected to be frequently associated with drowning or recreational aquatic activity.

These include those in the main category ‘Water craft and means of transport’ (category G), and those in specific categories identifying marine creatures (categories K51 to K59), watery places (categories L50 to L54), watery events (M19 and M29) or structures for swimming or bathing (R02, R13, R14 and R15). In addition, two object codes (P01 and Q09) identify alcohol as an involved object. These codes should, in theory, be able to be used to identify cases in which alcohol was meaningfully involved, although only P01 should be used for alcohol normally consumed (i.e. ethanol) (see Appendix 8.1).

Activity

The ‘Activity’ data element has nine main categories and many sub-categories. Drowning deaths could be expected to be in any of the activity categories, but deaths due to recreational aquatic activity would be expected to be coded to either of the ‘Sports and active recreation’ or ‘Leisure activity’ categories, or to the ‘Unspecified activity’ category. It is likely that only a small proportion of people classified to the sports and leisure categories would have been undertaking recreational aquatic activity. More specific sports categories are recorded for those deaths with an activity coded to ‘Sports and active recreation’, and several of these codes (those starting with ‘3.—Water team’, ‘4.—Boat’, or ‘5.—Individual water-based’) could be expected to identify recreational aquatic activity and to predominantly be applied to drowning cases.

Incident location

The ‘Incident Location’ data element has several categories that could be expected to contain a considerable proportion of the drowning deaths and the deaths due to recreational aquatic activity – ‘Aquatic recreation area’; ‘Other: water-based sport’; ‘Inland body of water’; ‘Other body of water – beach, ocean, etc’, ‘Wharf, pier, jetty, etc’; and ‘Bridge’. In addition, incidents that occur in home swimming pools and baths might be coded to ‘Home’, and those that occur in farm dams should be coded to ‘Farm’, although these last two categories could be expected to have a large proportion of deaths that are not connected to drowning or recreational aquatic activity.

Date of death and date of notification

Cases could be expected to usually be notified to the NCIS within a few days of death, so the date of death and the date of notification could be expected to be similar, but not necessarily the same, because notification could be delayed by various factors. Therefore, the period of interest is usually best defined by the date of death. However, for some cases, the date of death might not be known, or not coded in the NCIS (especially for *Open* cases) or incorrectly recorded in the NCIS. If only the date of death is used to identify the cases of interest, cases for which the date of death is not recorded would not be included using criteria based on the date of death. Conversely, if there is a delay in notification, some deaths that did occur during the period of interest would not be included if date of notification was used as the proxy criteria for identifying deaths of interest. Since date of notification is virtually always recorded, and this date is usually very close to the date of death, it can also be used as a filter to help identify deaths that occurred in the period of interest but which do not have a recorded date of death or which have an erroneous date of death.

Medical cause of death

The information on cause of death in the NCIS is currently recorded in free text form rather than being coded, although there are provisions for such coding to be recorded in the future.

There are six text fields in which the cause of death can be recorded, covering 1a, 1b, 1c, 1d and 2 on the death certificate, plus another field. Deaths due to drowning could be expected to be identified as such in at least one of these fields with words such as ‘drowning’, ‘drowned’, ‘immersion’ or ‘immersed’.

Obtaining data from the NCIS

Authorised users can obtain information from the NCIS by accessing the web site or by requesting information directly from MUNCCI staff. The web site provides access to individual cases and also allows data to be retrieved according to certain search criteria. The web site is preferred for access to individual cases or for small data requests. However, large or complicated data requests are better handled by the MUNCCI staff, who can provide the information in the form of one or more Excel files.

It is not currently possible to retrieve documents for more than one case through a search, whether via the web site or conducted by the MUNCCI staff, if information from other fields is also required. However, the documents and information from other fields should be obtainable through a series of searches.

Authorisation for access can be obtained after submission of an application and consideration of this by MUNCCI and relevant ethics committees. Information for this study was obtained under an agreement between MUNCCI and the Research Centre for Injury Studies at Flinders University.

Methods

Initial inclusion criteria

The intention was to identify all deaths of interest that occurred in a 12-month period. The 12-month period 1 July 2000–30 June 2001 was chosen because this was the earliest 12-month period covered by the NCIS and so could be expected to have the largest proportion of cases completed (or *Closed*). Information was provided by MUNCCI staff following discussions to finalise the search criteria.

Information was requested from the NCIS regarding all deaths that met the following criteria:

- date of notification on or between 1/7/2000 and 30/6/2001;

  AND/OR

- date of death on or between 1/6/2001 and 30/6/2001;

  AND

- Case type at notification OR case type at completion not equal to ‘Natural Cause’.

This meant that all deaths notified in the period of interest, or that occurred in the last month of the period of interest but that were notified later, would be included unless they were classified as ‘Natural Cause’ at both the time of notification and the time of completion. The Natural Cause group was excluded to decrease the number of cases that needed to be provided by MUNCCI and initially reviewed for the analysis.

Information from the whole of Australia, including Queensland, was desired, but it was known prior to the commencement of the study that Queensland data would not be available.

All relevant fields (apart from the Sports Activity water recreation codes) from the various NCIS forms were requested. Information for fields that have numeric codes was provided in coded form. The Sports Activity water recreation codes were obtained through a separate search of the NCIS web site at a later time.

The information reported on in this chapter was extracted in the week ending 11 October 2002. Cases described as *Open* or *Closed* refer to the case status at the time the data were extracted. The information was provided in two Excel files – one based on date of notification and a smaller one based on date of death for June 2001 deaths. These files were cleaned, unnecessary fields deleted and some new fields created on the basis of the original information provided. Duplicates of cases that appeared in both files were deleted. Cleaning included comparing dates of incident, death and notification looking for anomalies (e.g. the incident could not occur after the death, and notification could not occur before the death). Anomalies identified were resolved where possible by inspecting the relevant NCIS file on the web site and reading any attached files or other information. Most of the anomalies appeared to be typographical errors that occurred during data entry. For apparently in-range cases where the date of death was missing or wrong, where the dates of incident and notification were the same, and the recorded date of death one year later, the date of incident was accepted as the date of death. Where the recorded date of death was one year after the date of notification (or otherwise clearly a typographical error), but the date of incident was several days before the date of notification (or was a typographical error also), the date of notification was accepted as the date of death. The files were then imported into SAS and analysed.

Identifying in-range cases

Deaths (or cases) were defined as in-range if the death occurred on or between 1/7/2000 and 30/6/2001. The initial files obtained from the NCIS contained 6,467 different observations. A further two deaths with a Case Type of Natural Cause at both Notification and Completion were identified through a separate search of the NCIS web site (described later) and added to the main file, making the total number of cases 6,469. Of these, 6,178 deaths were initially in-range (that is, they had a date of death on or between 1/7/2000 and 30/6/2001). These deaths had a date of notification in-range or within a few months after 30 June 2001. Another 180 cases with missing date of death (150) or date of death erroneously recorded as before 1 July 2000 (eight) or date of death erroneously recorded as after 30 June 2001 (22), were accepted as in-range deaths on the basis of the dates of incident and notification and/or other information. This left a total of 6,358 in-range deaths.

Basic description of in-range cases

External Cause was the main Case Type at Notification and at Completion for in-range cases. All cases with a missing Case Type at Completion were *Open* cases (Table 3.1).

Table 3.1: Case Type at Notification and Completion for all in-range cases, case count and per cent; Australia (excluding Queensland), July 2000–June 2001

Case Type	Case count	Per cent
At Notification		
Natural	134	2%
External	5,046	79%
Still enquiring	181	3%
Not known	995	16%
Missing	2	0%
Total	**6,358**	**100%**
At Completion		
Natural	765	12%
External	4,427	70%
Not known	129	2%
Missing	1,037	16%
Total	**6,358**	**100%**

Sixty eight per cent of all cases, and 66% of cases with a Case Type at Notification of *External Cause*, were *Closed*.

Identifying drowning deaths and non-drowning recreational aquatic injury deaths

Drowning deaths were identified through any of the Mechanism, Cause of Death, Object or Location fields. Other injury deaths related to recreational aquatic activity were identified through any of Object, Location or Cause of Death fields. New variables were created to allow easy identification of these deaths during the analysis.

Mechanism of injury

Mechanism was present for 71% of all cases (both *Open* and *Closed*). Only 6% of cases with missing Mechanism were *External Cause* cases at Completion, and only 3% of *External Cause* cases at Completion had a missing Mechanism (note that Mechanism is not coded for natural cause deaths).

Two hundred and fourteen drowning cases were identified as drowning on the basis of the Mechanism (= '*J2 : Drowning and immersion*'). All but three of these had the drowning code as the Primary Mechanism (although some of these had the drowning code as a Secondary Mechanism as well). The other three had drowning as the Secondary Mechanism, but a different Primary Mechanism.

Cause of death

Two hundred and eleven cases had a text string 'DROWN' (in words such as 'drowning' or 'drowned') in one or more fields describing the cause of death. Another 57 cases had the text string 'IMMERS' (primarily in the word 'immersion') in the Cause of Death fields. Eight cases had both strings. All of these 260 cases were persons who drowned, and of the 204 with non-missing Mechanism field, 95% had a Mechanism of *drowning*.

Only one case had the text string 'BOAT' in any Cause of Death field, and this case involved a non-drowning recreational aquatic activity death.

Object or substance producing injury

Watercraft or boats were recorded as objects in 18 deaths (all External Cause at Completion deaths). Thirteen of these had a Mechanism of drowning. Five more involved an incident in a boat, three resulting in probable drowning and two in other fatal injuries.

Places such as dams, lakes, rivers, beaches and oceans were recorded as one of the objects in 137 cases. One hundred and twenty five of these had a Mechanism of drowning. Of the other 12, three deaths were due to drowning (one suicide, one whilst doing recreational underwater diving, and one following a motor vehicle crash). Eight of the remaining nine deaths were due to multiple injuries (seven from suicide jumps off a bridge or a cliff, and one from a fall onto rocks whilst walking), and one was from exposure when lying in a swamp.

One further death, of a surfer attacked by a shark, was identified because the object coding was *'shark'*.

Activity

The activity at the time of the incident was Sports and Active Recreation (127) or Leisure Activity (695) in 822 (13%) cases. Activity was missing or unknown for 862 (14%) cases. Of the 127 deaths with an activity coded as *Sports and Active Recreation*, 40 (31%) had a Mechanism code of *drowning*. Of the 694 deaths with an Activity coded as *Leisure*, 60 (9%) had a Mechanism code as *drowning*.

Of the 127 deaths with an activity coded as *'sports'*, 81 had a specific Sports activity code assigned. Forty-seven of these had a Sports Activity code identifying water sports, 34 of which had a Mechanism of *drowning*, and another two persons drowned but had a different Mechanism code. Of the remaining 11, three had already been identified as non-drowning recreational aquatic injury deaths, one involved a surfer who was attacked by a shark, five had a sports code of fishing but no other information, and one had information suggesting that the deceased person suffered fatal head injuries due to a collision with a buoy while involved in water-based activity. Interestingly, the NCIS status of two of these fishing deaths became *Closed* following data extraction for this project. At the time of extraction there was virtually no coded information available at all for these cases, so there was no way of identifying the Mechanism, Cause of Death, or the Activity or Location at the time of the incident. Once the cases were *Closed*, further information became available, which revealed that both deaths had involved drowning during recreational fishing.

The remaining case, which was the only one of the 11 that was *Closed* at the time of data extraction, involved an elderly woman who died while swimming at a beach, but whose final cause of death was recorded as due to ischaemic heart disease and for whom the Coroner specifically stated that she did not drown.

Incident location

The specific location of the person at the time of the incident was known for all but 15 deaths (although the general location was recorded as unknown for 217 deaths). The recorded location was associated with water for four per cent of deaths. Inland bodies of water and the sea/ocean each comprised about half of these locations (Table 3.2).

Table 3.2: Location of incident only for locations associated with water, all cases; Australia (excluding Queensland), July 2000–June 2001

Location	NCIS Code	Case count
Aquatic recreation centre	54	8
Inland body of water	124	111
Other water (e.g. ocean)	125	127
Wharf, pier, jetty	126	2
Bridge	127	8
Total		**256**

One hundred and forty two of the 256 deaths with a water-associated Place of Incident had a Mechanism of *drowning*, 48 did not, and 66 had a missing incident mechanism. Because of the large number of cases, only the *Closed* cases were inspected on the NCIS web site to see if other information could clarify if any involved drowning or other injuries during water recreation. This revealed eight extra drowning cases and seven cases involving other injuries during water recreation.

Search of the NCIS web site for other cases

The initial data request from the NCIS included all deaths apart from those that were coded as *Natural Cause* at both notification and completion. Since the initial review of the data identified several drowning cases with a final case type of *Natural Cause*, it was considered that some drowning deaths could potentially have been missed by excluding *Natural Cause* deaths. Therefore, searches were undertaken of the NCIS web site looking for cases with a *Natural Cause* Case Type at both Notification and Completion, that were in-range, and in which the person had died as a result of drowning. The search criteria were:

- 'drown' in any of the cause of death fields; AND/OR
- 'immers' in any of the cause of death fields; AND/OR
- sports activity coded to 'fishing', 'other boat', 'surfing', 'swimming', 'scuba' or 'water skiing'.

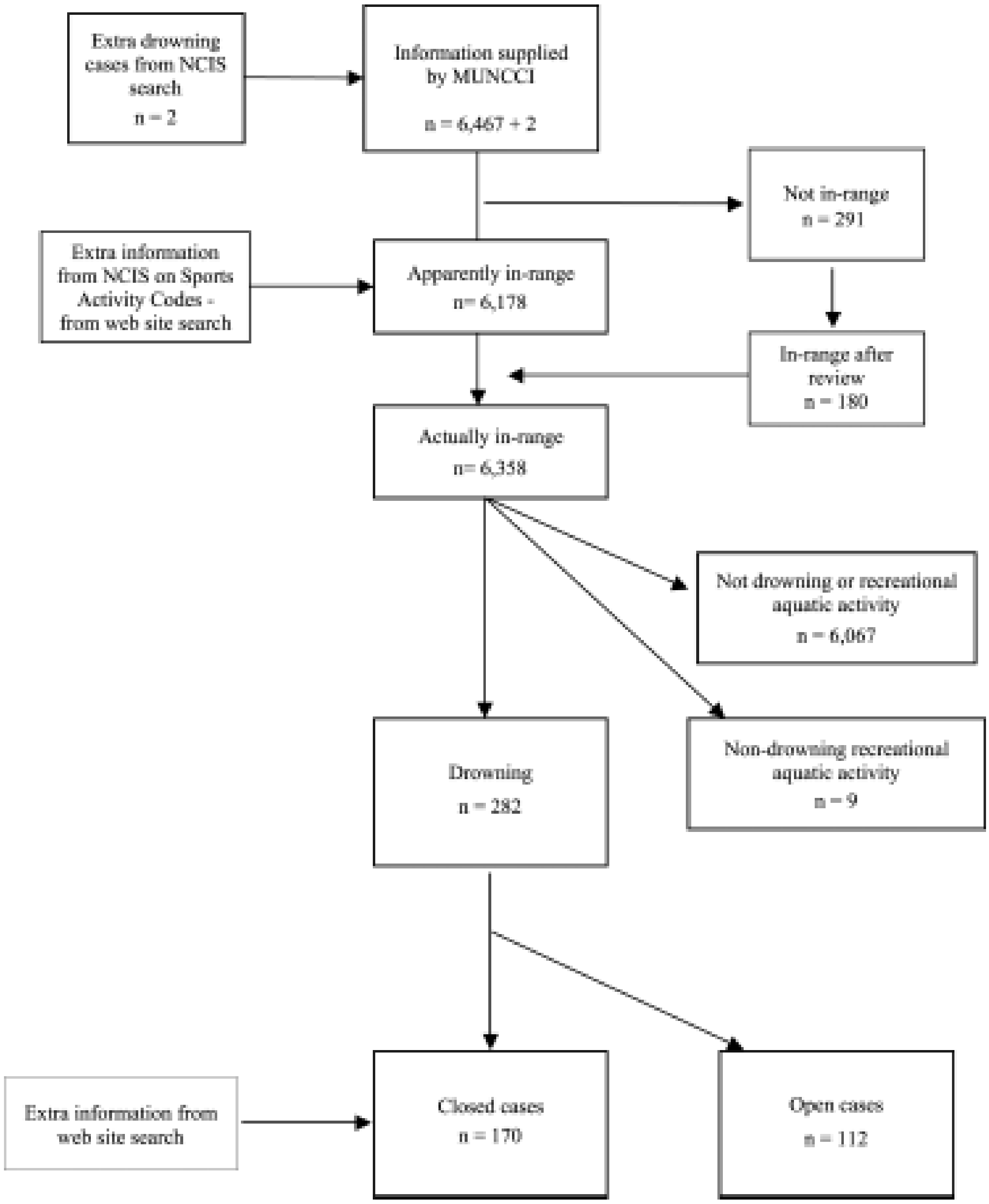
Two new cases were identified using this approach – one person who drowned in a creek while swimming (this case was still *Open*), and one person who had drowned in a public pool while swimming (this case was *Closed*). In both cases, ischaemic heart disease was identified in the Cause of Death in addition to the drowning. However, since this also occurred for some of the other cases included from the main data set supplied by the NCIS, it was decided that these two cases should be included.

Additional cases which satisfied the activity criteria were not included as they all involved people dying directly from heart attacks while undertaking one of the identified activities, but with no contribution from drowning and no apparent causal relationship to the recreational aquatic activity.

Final data set for analysis

The results of this consideration of the coded and brief text variables, and some text documents, were combined to produce a data set that was presumed to contain all drowning deaths, and, in addition, all non-drowning injury deaths that were due to recreational aquatic activity. There were 291 deaths that were due to either drowning, or to non-drowning injury during recreational aquatic activity. Of these, 61% were *Closed*. Since 97% (282) of the deaths were due to drowning, the nine non-drowning deaths arising from recreational aquatic activity are analysed separately later in this Chapter. The data flow is shown in Figure 3.1.

Figure 3.1: Summary of the data flow for drowning cases, NCIS; Australia (excluding Queensland), July 2000–June 2001



Results

All drowning deaths

Main characteristics

The main characteristics of the coded and brief text information for the 282 drowning deaths, stratified by Case Status, are shown in Table 3.3. The results for the *Closed* cases are presented in more detail in the second section of the results.

Differences between *Closed* cases and *Open* cases

The primary focus of this study was the role of alcohol in drowning deaths. A secondary consideration was the role of alcohol in deaths (whether from drowning or other causes) arising from recreational aquatic activity. The only fields available for *Open* and *Closed* cases that provide information on alcohol presence or absence are the three Object fields (although theoretically reference to alcohol could be included in the Cause of Death fields). However, the inclusion of alcohol as an Object could be expected to be inconsistent in cases where alcohol may well have played a role. Also, almost half the *Open* cases had no object recorded at all. Therefore, assessment of the accuracy of this alcohol coding is required before it can be relied on, as it is likely that the object variables would provide a considerable underestimate of the true number of cases involving alcohol. Information on alcohol was expected to usually be present in toxicology documents, and less reliably in autopsy, police and Coroner's Finding documents, but these documents are only available for *Closed* cases.

Similarly, the Incident Activity data element provides only limited information that can be used to identify or exclude recreational aquatic activity, whereas information that could allow these deaths to be identified might be expected to be present in police documents or Coroner's findings.

Therefore, a proper consideration of the role of alcohol in drowning, or of the circumstances of deaths arising from recreational aquatic activity, requires access to text documents. As previously stated, the text documents were only available for *Closed* cases. For this reason, the rest of the analysis was confined to *Closed* cases.

The main determinant of whether a case is *Closed* or *Open* is the time since the death occurred. Therefore, there are few a priori reasons that would suggest that *Closed* cases might differ importantly to *Open* cases. Perhaps the most important concern is that the period covered by the analysis runs from July–June. Deaths that occurred early in the study period would be more likely to be *Closed* than deaths that occurred later in the study period. Indeed, this is borne out by the data in this study, which showed a decreasing proportion of *Closed* cases for more recent dates of death (Table 3.4).

Table 3.3: Main characteristics of drowning deaths by case status, per cent; Australia (excluding Queensland), July 2000–June 2001

Data element	*Closed* (n = 170)	*Open* (n = 112)	Total (n = 282)
Sex and age			
Male	78%	79%	78%
Missing	1%	1%	1%
Average Age (standard deviation)	41.8 years (22.9)	42.8 years (22.6)	42.2 years (22.8)
Mechanism			
Drowning	94%	49%	76%
Case type at notification			
External	86%	89%	88%
Natural	2%	4%	3%
Still enquiring	0%	4%	2%
Not known	12%	3%	8%
Case type at completion			
External	95%	53%	78%
Natural	3%	4%	3%
Not known	2%	0%	1%
Missing	0%	44%	17%
Intent at notification			
Unintentional	65%	45%	57%
Intentional self-harm	16%	6%	12%
Not known	16%	2%	10%
Missing	4%	46%	21%
Intent at completion			
Unintentional 74%	44%	62%	
Intentional self-harm	17%	7%	13%
Not known 6%	1%	4%	
Missing 3% 48%	21%		
Cause of death			
Drowning / immersion	94%	90%	92%
Cause of death includes heart disease	5%	12%	7%
Missing	2%	7%	4%
Object	%		
Body of water	52%	34%	45%
Swimming pool	9%	3%	6%
Boat	8%	4%	7%
Bath	8%	3%	6%
Alcohol	10%	0%	6%
Missing	10%	47%	25%
Activity			
Sports and Active Recreation	12%	29%	19%
Leisure	26%	37%	31%
Work	1%	4%	2%
Other specified	37%	12%	27%
Unknown	11%	5%	9%
Missing	0%	7%	3%
Location			
Inland body of water	26%	29%	28%
Other body of water (e.g. ocean, sea, etc)	36%	32%	34%
Aquatic recreation centre	0%	3%	2%
Home	19%	13%	16%

Table 3.4: Case status by date of death for drowning cases and all cases, case counts and per cent; Australia (excluding Queensland), July 2000–June 2001

Time period	Drowning cases		All cases	
	Case count	% *Closed*	Case count	% *Closed*
1 Jul 2000–30 Sep 2000	43	81%	1,708	78%
1 Oct 2000–31 Dec 2000	84	67%	1,654	75%
1 Jan 2001–31 Mar 2001	93	57%	1,451	61%
1 April 2001–30 Jun 2001	62	42%	1,543	54%
1 Jul 2000–30 June 2001 (All)	**282**	**60%**	**6,358**	**68%**

Both aquatic activity and survival in water are highly dependent on the ambient and water temperatures – recreational aquatic activity is more common in the warmer months (approximately November to March) and survival in the water less common in the colder months (approximately May to September). Since the study period commenced early in winter, deaths that occurred in the Winter and Spring will be more likely to be *Closed*, and so be preferentially included in an analysis only of *Closed* cases, than deaths that occurred in Summer or Autumn.

Similarly, deaths that involve some unusual or uncertain aspect, or that may be the subject of criminal charges, could be expected to take longer to be resolved, and so to stay *Open* for longer. Therefore, limiting an analysis to only *Closed* cases may exclude a greater proportion of these deaths than other types of death. Deaths in which homicide or suicide is suspected seem potentially vulnerable to this source of bias. However, deaths resulting from intentional self-harm did not appear to take longer to close than other deaths. A lower proportion of deaths coded as resulting from interpersonal violence were closed, but there were not many of these cases, and none identified in the known drowning cases (Table 3.5).

Table 3.5: Intent at notification by case status for drowning cases and all cases, case counts and per cent; Australia (excluding Queensland), July 2000–June 2001

Intent	Drowning cases		All cases	
	Case count	% *Closed*	Case count	% *Closed*
Unintentional	161	68%	2,402	79%
Interpersonal violence	0	—	146	62%
Deliberate self-harm	34	79%	1,576	81%
Not known	29	93%	646	93%
Missing	58	10%	1,518	26%
All deaths	**284**	**60%**	**6,358**	**68%**

Fortunately, the results in Table 3.3 show that the main characteristics of *Closed* drowning deaths were similar to the characteristics of *Open* drowning deaths. This suggests that the results obtained for *Closed* cases should be broadly applicable to all drowning deaths that occurred in the 12-month period under study.

Comparison to national deaths data on drowning deaths

In order to assess the completeness of coverage of drowning deaths provided by the NCIS, a comparison was made with ABS deaths data. National deaths data for the period covered by this study were not available from the ABS at the time of preparation of this report. Therefore, data were analysed for all deaths that occurred in the 12-month period prior to that covered by this study, namely deaths that occurred on or between 1 July 1999 and 30 June 2000 (and which were registered by 31 December 2000). The basis for this approach was that the number of drowning deaths is likely to be similar in adjacent years, and even if the number changes, the relative proportions of various characteristics of the person or the circumstances of death are likely to be reasonably stable. Therefore, important differences between the numbers and characteristics of cases in the two data sets would suggest a problem of coverage and/or coding in one or both data sets.

There are several data items that can be used to identify drowning deaths in the ABS deaths data, including the 'Drowning' flag, the UCoD ICD-10 code and any MCoD ICD-10 code. All deaths that satisfied at least one of the following criteria were accepted as drowning deaths in the ABS data set:

- deaths for which the 'Drowning' flag was set;
- deaths for which the UCoD field, or any MCoD field, contained any ICD-10 External Cause code which implies drowning (i.e.V90, V92, W65–W74, X71, X92, or Y21);
- deaths for which any MCoD field contained ICD-10 code T75.1 ('drowning and non-fatal submersion').

These criteria were considered to provide the best match to the inclusion criteria used in the NCIS analysis. Queensland deaths were excluded from the analysed ABS data because Queensland data are not currently included in the publicly available component of the NCIS.

The ABS deaths data contained registrations of 293 deaths that occurred in 1999–00 and that satisfied the above criteria for a drowning death. The number of drowning deaths identified in the NCIS for the subsequent 12 months was very similar – 282. A State and Territory-based comparison also revealed very similar proportions in each jurisdiction during the two time periods. The proportion of males in the two data sets was similar (74% in the ABS versus 78% in the NCIS). Assuming that the ABS data contain all relevant deaths, these results suggest that virtually all drowning deaths were reported to the NCIS and were identifiable through use of the data fields and approach described here (Table 3.6).

Note that the basis for this comparison is the fact that (with a few minor exceptions) unexpected deaths are reported to a coroner. Assuming all drowning cases would be classified as unexpected deaths, the numbers in the NCIS and ABS data set should be comparable for drowning.

Table 3.6: Comparison of drowning deaths identified from NCIS (2000–01) and ABS (1999–00), case counts and per cent; Australia (excluding Queensland)

State / Territory	NCIS (2000–01)		ABS (1999–00)	
	Case count	Per cent	Case count	Per cent
New South Wales	140	50%	120	41%
Victoria	71	25%	73	25%
South Australia	21	7%	33	11%
Western Australia	23	8%	38	13%
Tasmania	16	6%	20	7%
Northern Territory	8	3%	5	2%
Australia Capital Territory	3	1%	4	1%
Total	**282**	**100%**	**293**	**100%**

Deaths involving drowning and disease

A small minority of the deaths identified by national deaths data appear to be '*Natural Cause*' deaths where the deceased person had an epileptic seizure and drowned. Also, some of the deaths included in the first data set provided by MUNCCI contained deaths which appeared to be due to drowning but for which either the notification or completion Case Type was coded as '*Natural Cause*'. Cases for which the circumstances of death involved epilepsy or ischaemic heart disease as well as immersion, and which had been coded as Natural Cause at both notification and completion, would not have been included in the initial data set provided by the NCIS. In an attempt to identify such deaths, deaths coded in the NCIS as '*Natural Cause*' at both the time of notification and the time of completion were searched for text suggestive of drowning, but only two extra in-range cases were found, and neither of these involved epilepsy. However, there was at least one death that did, or probably did, involve epileptic seizures and resultant drowning that had already been included as a case because either the notification case type or the completion case type were not 'Natural Cause'.

Therefore, it is unlikely that deaths involving medical conditions and immersion that were coded to Natural Cause rather than External Cause would be in the NCIS but not be identified in the approach used here to identify all drowning cases.

Drowning deaths–*Closed* cases

The presence and general content of attached documents

For each of the 170 drowning cases that were *Closed*, the unit record file on the NCIS web site was inspected. Up to four documents were attached to each file – the police report, the autopsy report, the toxicology report and the finding. For each case, note was made of which of these documents was present. When present, the documents were read, looking for reference to the use (or lack of use) of alcohol, and for information on the circumstances of the fatal incident. Where alcohol values were present, these were recorded, along with any mention of whether body decomposition may have contributed to the measured alcohol level. This information was coded and entered into an Excel file, which was then combined with the SAS file based on the original information obtained from the NCIS.

Police reports were present for 91% of cases, but autopsy reports, toxicology reports and the Coroner's finding were present in only about half the cases. However, the percentage of cases with toxicology reports is misleading, because in New South Wales all autopsy reports that were present contained the standard toxicology results, and no New South Wales case had a separate toxicology report. Therefore, toxicological information was actually available in 72% of New South Wales' cases, and in 71% of cases overall.

There was considerable variation between jurisdictions in terms of proportions of cases with various documents. Victoria, Tasmania, the Northern Territory and the Australian Capital Territory had high proportions of cases with a police report, autopsy report and finding. All Western Australian cases had a police report and nearly two thirds had a toxicology report, but few had a finding or autopsy report, while all South Australian cases had only a police report. Only 9% of New South Wales' cases had a finding. This is most likely due to the fact that the New South Wales coronial offices only produce a finding document when a hearing has been held. There were also qualitative differences between jurisdictions. For example, the police reports for most jurisdictions were usually several paragraphs in length, but for South Australian cases they were often only one or two lines. It should be noted that the qualitative differences between these police reports results from the procedure adopted in each jurisdiction, and the decision as to what the jurisdiction will/will not provide the NCIS. Many of the autopsy reports had considerable information describing the circumstances of death, and New South Wales autopsy reports commonly had a copy of the P79A, the police notification to the Coroner, at the end of the report. The P79A sometimes provided additional information to that provided by any attached police report. The implications of this variability in the availability and contents of documents are considered later in this chapter (Table 3.7).

Table 3.7: Presence of documents on NCIS web site by State/Territory for Closed drowning cases only, case counts and per cent, Australia (excluding Queensland), July 2000–June 2001

State / Territory	Case count	Police report	Autopsy	Toxicology report	Finding
New South Wales	46	70%	72%	0%	9%
Victoria	67	100%	67%	94%	88%
South Australia	17	100%	0%	0%	0%
Western Australia	21	100%	5%	62%	19%
Tasmania	8	88%	63%	38%	88%
Northern Territory	8	100%	88%	63%	100%
Australia Capital Territory	3	100%	100%	67%	100%
Total	**170**	**91%**	**55%**	**51%[a]**	**50%**

(a) The total is 71% when toxicology information from the autopsy report for NSW cases is included.

Information on alcohol

Attached documents

For all cases, explicit information on alcohol involvement was available for 72% of cases, but this varied from 91% in Victoria to 12% in South Australia. When such information was available, it usually came from the toxicology report (which, for New South Wales, was in the autopsy report). Alcohol information was available from the autopsy report in all New South

Wales cases, and in around one-third of cases from Victoria, Tasmania, the Northern Territory and the Australian Capital Territory (Table 3.8).

Table 3.8: Availability of information on alcohol in documents on NCIS web site – as a percentage of all cases by State/Territory for Closed drowning cases only, per cent; Australia (excluding Queensland), July 2000–June 2001

State / Territory	Case count	Police report	Autopsy	Toxicology report	Finding	Any
New South Wales	46	7%	72%	0%	0%	72%
Victoria	67	18%	39%	90%	24%	91%
South Australia	17	12%	0%	0%	0%	12%
Western Australia	21	10%	0%	62%	5%	67%
Tasmania	8	13%	38%	38%	13%	63%
Northern Territory	8	0%	38%	63%	63%	63%
Australian Capital Territory	3	0%	33%	67%	0%	67%
Total	**170**	**12%**	**39%**	**49%[a]**	**14%**	**72%**

(a) The total is 68% when toxicology information from the autopsy report for NSW cases is included.

The previous analysis provides information on the percentage of cases for which alcohol information was available. It is also useful to examine what percentage of documents that **are** present contain information on alcohol, and what sort of information is available. Virtually all the toxicology documents contained information on alcohol. About 70% of autopsy documents contained alcohol information, but this varied considerably between jurisdictions, and was 100% in New South Wales. A definitive statement on alcohol was uncommon (27% overall) in findings, and rare (13% overall) in police reports (Table 3.9).

The quality of information also varied between reports. Toxicology reports usually contained quantitative information, but rarely mentioned if the body was decomposed to an extent that might have influenced the validity of the result. In contrast, the state of decomposition of the body and its possible influence on any non-zero alcohol values was commonly mentioned in autopsy reports, which also not uncommonly contained the quantitative level of alcohol reported in any available toxicology report for the case. Information in the finding, when present, was variable, sometimes mentioning the quantitative level of alcohol and sometimes that the person had, or less commonly had not, been drinking. When police reports did mention alcohol, in all but one case it was to note that alcohol had been consumed rather than that it had not.

Involved object

Alcohol was coded as an involved object in 10% of drowning cases, mainly as a secondary or tertiary object. All but one of these were cases in which other information suggested alcohol did contribute to the fatal incident or its aftermath. The remaining case was of a person who had a post mortem blood alcohol of 0.03g/100ml that was almost certainly due to body decomposition. Only 53% of the 30 deaths in which alcohol appeared to play a role had alcohol coded as an object.

Table 3.9: Availability of information on alcohol in documents on NCIS web site – per cent of cases with documents by State/Territory for Closed drowning cases only; Australia (excluding Queensland), July 2000–June 2001

State / Territory	Police report	Autopsy	Toxicology report	Finding
New South Wales	9%	100%	—	0%
Victoria	18%	58%	95%	27%
South Australia	12%	—	—	—
Western Australia	10%	0%	100%	25%
Tasmania	14%	60%	100%	14%
Northern Territory	0%	43%	100%	63%
Australia Capital Territory	0	33	100	0
Total	**13**	**70**	**97**	**27**

Identifying drowning deaths

The use of various NCIS fields to identify drowning deaths in the overall data set was described earlier. This section summarises this information for *Closed* drowning cases and considers the usefulness of the fields for this purpose.

Mechanism

All but three *Closed* cases had at least one Mechanism recorded. *Drowning* was recorded as a Mechanism in 94% of drowning cases, in all but three as the Primary Mechanism. All of these cases were true drowning cases, and there were no non-drowning cases with *Drowning* recorded as a Mechanism. Non-drowning Primary Mechanisms recorded for true drowning cases were *Contact with a Blunt Object; Falling, Stumbling, Jumping; Mechanical Threats to Breathing; Poisoning by Liquid Substances;* and *Other Specified Effect of Chemical Substances*.

Object

Half of the drowning cases had a body of water coded as an object, and another 25% had a boat, swimming pool or bath as an object. Also, the vast majority (92%) of deaths associated with these groups of objects were drowning deaths (Table 3.10).

Table 3.10: Relationship between object and drowning deaths for selected objects for Closed cases only, case counts and per cent; Australia (excluding Queensland), July 2000–June 2001

Object	Case count	Per cent that were drowning deaths	Per cent of drowning deaths
Body of water[a]	97	92%	52%
Watercraft	16	88%	8%
Swimming pool	15	100%	9%
Bath	15	87%	8%
Total	**143**	**92%**	**77%**

(a) Includes fish pond, ornamental lake, dam, lake, water reservoir, river, stream, swamp, marsh, beach, seashore, sea and rocks.

Activity

There was no broad Activity code that identified primarily drowning cases. The most useful Activity codes for identifying drowning cases were those associated with water-based activities within the *Sports and Active Recreation* category. Eighty six per cent of cases with an activity code that identified water sports were true drowning cases, but only 11% of drowning cases had a water-based sports activity code.

Location

Four specific locations identify places where most drowning events are likely to occur – *Inland Body of Water, Other Body of Water; Wharf, Pier, Jetty;* and *Aquatic Recreation Centre*. Seventy six per cent of deaths in these four categories were true drowning cases, and these deaths represented 66% of all drowning cases (Table 3.11).

Table 3.11: Relationship between place of incident and drowning deaths for selected places for Closed cases only, case counts and per cent; Australia (excluding Queensland), July 2000–June 2001

Place	Case count	Per cent that were drowning deaths	Per cent of drowning deaths
Inland body of water	69	65%	26%
Other body of water—beach, ocean, etc	69	88%	36%
Wharf, pier, jetty	2	50%	1%
Aquatic recreation centre	7	71%	3%
Total	**147**	**76%**	**66%**

Cause of death

One hundred and fifty nine (94%) of the 170 drowning cases had a text string of either 'DROWN' (126), 'IMMERS' (29) or both (4) in one or more of the cause of death fields. All cases with either of these text strings in the cause of death fields were true drowning cases.

Processing time for cases

The mean time between the date of incident and the date of death was 0.76 days (SD = 3.6 days), with 77% of deaths occurring on the day of the incident, and another 15% occurring the day after. The mean time to notification was 3.0 days (SD = 12.6), with 54% of deaths notified to the Coroner on the same day, another 21% the day after, and 98% of all deaths notified within one month. The mean time from notification to closure was 401 days (SD = 188), and the median time was 449 days.

Summary of Closed drowning cases

Circumstance

The main circumstance types involved in the drowning cases were recreational aquatic activity (45%), incidentally contacting water while undertaking a non-water activity (such as walking nearby and falling in – 26%) and intentional self-injury (16%). Four of the recreational activity incidents involved the drowning death of a person attempting to rescue a family member from the water. Five of the 'incidental' incidents involved persons cleaning or doing other maintenance in or near a pool area (but not in the pool itself) who fell into the pool and drowned (Table 3.12).

Table 3.12: Circumstance at the time of the fatal incident for drowning cases only, case count and per cent; Australia (excluding Queensland), July 2000–June 2001

Circumstance	Case count	Per cent
Recreational	76	45%
Incidental	44	26%
Intentional self-harm	28	16%
Occupational	5	3%
Water-associated but not recreational	2	1%
Deliberate – assault	1	1%
Uncertain but possibly recreational	3	2%
Uncertain but probably not recreational	9	5%
No information	2	1%
Total	**170**	**100%**

Location

The drownings occurred in a variety of places: at or near a beach (26%), rocky foreshore (6%) or open water (6%); rivers and creeks (19%); and private swimming pools (11%) were the most common (Table 3.13).

Table 3.13: Location of the fatal incident for drowning cases only, case counts and per cent; Australia (excluding Queensland), July 2000–June 2001

Location	Case count	Per cent
Beach	45	26%
Ocean – rocks	10	6%
Open water	14	6%
Jetty—salt water	6	4%
River	33	19%
Lake / reservoir	13	8%
Jetty—fresh water	1	1%
Pool—private	18	11%
Pool—public	4	2%
Farm dam	7	4%
Bath	11	6%
Spa	3	2%
Other / not known	5	3%
Total	**170**	**100%**

Specific activity for drowning deaths during recreational aquatic activity

Half of the drowning deaths that occurred during recreational aquatic activity involved persons swimming. Fishing accounted for another quarter (evenly spread between rock fishing and other fishing), while surfing, boating and scuba accounted for much smaller proportions (Table 3.14).

Table 3.14: Specific activity during recreational aquatic activity deaths for drowning cases only, case count and per cent; Australia (excluding Queensland), July 2000–June 2001

Location	Case count	%
Swimming	38	50
Surfing	5	7
Rock fishing	9	12
Scuba	4	5
Boating	5	7
Other fishing	10	13
Other and unknown	5	7
Total	**76**	**100**

The role of alcohol

The level of blood alcohol was known for 119 (70%) of the 170 *Closed* cases. Excluding results for the 16 deaths in which there was significant decomposition of the body prior to the level of alcohol being taken, blood alcohol levels were known for 68% (105 of 154). For cases where the blood alcohol was known, it was zero for 79%, less than 0.05 g/100ml for 3% and 0.10 g/100ml or greater for 19% (19 cases) (Table 3.15).

Table 3.15: Blood alcohol values for drowning cases. All cases and cases with valid values, case counts and per cent; Australia (excluding Queensland), July 2000–June 2001

Blood alcohol value	All cases		Cases with valid values[a]	
	Case count	Per cent	Case count	Per cent
0	83	49%	83	79%
0 – 0.049	9	5%	3	3%
0.050 – 0.079	3	2%	0	—
0.080 – 0.099	0	—	0	—
0.100 – 0.199	9	5%	6	6%
0.200 – 0.299	12	7%	10	10%
0.300 – 0.399	3	2%	3	3%
Not known	51	30%		
Total	**170**	**100%**	**105**	**100%**

(a) Excludes cases with significant body decomposition and cases with unknown blood alcohol values.

Determining whether alcohol made a contribution to the occurrence of an event is not always straightforward. Each of the cases in which alcohol appeared to have contributed is described briefly in Table 3.16, based on the information in the NCIS. Each person's blood alcohol level is also presented, where known. The descriptions are presented separately for cases with known blood alcohol, unknown blood alcohol, and blood alcohol level possibly affected by body decomposition.

Table 3.16: Circumstances of death for deaths where alcohol appeared to contribute—only deaths with known alcohol level and no significant body decomposition; Australia (excluding Queensland), July 2000–June 2001

Alcohol level g/100ml	Circumstances
Known, valid blood alcohol values	
0.020	Teenage boy who drowned when he jumped into rough seas off rocks to swim. He was estimated to have drunk six cans of a spirit and cola mix over several hours leading up to the incident. A companion who had not been drinking got into difficulties but survived.
0.037	Adult male who drowned in a public dam when swimming near the slipway. The circumstances of drinking were not recorded.
0.046	Adult male who drowned swimming at an unpatrolled surf beach. He had consumed six drinks of beer and two spirit drinks the night before and another large stubby of beer about three hours before the incident, which occurred in the mid-afternoon.
0.100	Adult male who drowned when fishing in a waterhole. He had consumed a significant but unknown amount of alcohol, and a significant quantity of diazepam.
0.133	Adult male who drowned in unknown circumstances when rock fishing alone. The circumstances of drinking were not recorded, but he was on a fishing trip with friends.
0.140	Adult male who drowned when he jumped into the water from a pier to swim. He had been drinking a significant amount of beer for many hours prior to the incident.
0.154	Adult male who drowned when he fell out from a powered dinghy which hit an object while the man was retrieving crab pots from the mouth of a river at night. He had consumed about six cans of beer in the hours prior to the incident
0.176	Adult male who drowned in a public dam while kayaking alone at night. He had consumed an unknown but considerable amount of red wine in the hours immediately before the incident.
0.180	Adult male who drowned in a suburban river in unknown circumstances. He had consumed an unknown but considerable amount of beer in the hours immediately before the incident.
0.214	Adult female who drowned when she fell in the family pool in unknown circumstances but, according to the pathologist, probably with some relationship to coronary artery disease as well as the alcohol intoxication. She had consumed an unknown amount of alcohol at a party earlier in the evening.
0.220	Adult male who drowned in a public dam while in the water guiding a stalled powerboat back to a loading ramp. According to the pathologist, there was probably some relationship to a myocardial arrhythmia as well as the alcohol intoxication. He was reported to have consumed two cans of full strength beer immediately beforehand.
0.220	Adult male who drowned when he dived off the end of a salt water boat ramp into cold, shallow water (one and a half to two metres) – he possibly hit his head in the dive. He had consumed a large but unknown amount of alcohol overnight in the hours leading up to the incident.
0.220	Adult female who drowned when the vehicle in which she was a front seat passenger accidentally drove off the edge of a boat ramp or pier at night in poor visibility. The driver was also intoxicated and also drowned. The circumstances of her drinking are not known.

Alcohol level g/100ml	Circumstances (Table 3.16 continued)
Known, valid blood alcohol values	
0.220	Adult female who drowned when the vehicle she drove accidentally went off the edge of a boat ramp or pier at night in poor visibility. The passenger was also intoxicated and also drowned. The circumstances of her drinking are not known.
0.260	Adult male who drowned when he either fell or jumped into a suburban river. He was known to be intoxicated at the time, but the circumstances of the drinking were not recorded.
0.262	Adult female who drowned when she entered the water at a beach with the intention of taking her life. The circumstances of her drinking were not recorded, but she was described to be ‘suffering from alcoholism’.
0.280	Adult male who drowned in a river in uncertain circumstances but probably when he fell in while intoxicated. He had been sitting next to the river drinking wine for several hours and had been too drunk to stand up when last seen.
0.282	Adult female who intentionally drowned herself in her bath while under the influence of alcohol and several central nervous system depressant medications. She was described as being a heavy drinker.
0.293	Adult female who unintentionally drowned when she jumped off a 15 to 20 metre cliff in unknown circumstances. She was described as being heavily intoxicated and possibly under the influence of drugs.
0.321	Adult male who drowned swimming across a river. He was described as having been drinking heavily immediately before the incident.
0.360	Adult male who drowned while swimming in a river with other people while heavily intoxicated. He was described as being a binge drinker and as having been on a ‘bender’ on the day of the incident.
0.375	Adult male who unintentionally drowned in his backyard swimming pool in uncertain circumstances. There was no information regarding his alcohol intake but ‘acute alcohol intoxication’ was included in the cause of death.
Known blood alcohol values but body decomposed	
	0.020 Adult male who drowned crossing a creek or drain at night. He was described as having been heavily intoxicated following drinking at a bar.
0.060	Adolescent boy who drowned when swept away from storm water channel in which he had been sitting and carrying out graffiti. He had been drinking cans of spirit and cola at the time and was described as being ‘drunk’.
	0.137 Adult male who was assaulted and probably deliberately drowned in a storm water channel. The pathologist described the blood alcohol level as indicating moderate intoxication, but the circumstances of drinking were not described.
0.186	Adult male who drowned when his runabout collided with a bridge pylon in a river at night. The man had been drinking at a hotel and was described as being intoxicated.
	0.200 Adult male who drowned in a bay when he fell out of the kayak he was paddling with a friend at night. He had been drinking heavily before and during the kayak trip.
0.213	Adult male who drowned whilst swimming from a jetty in salt water during the day. He had been drinking a considerable amount of wine prior to swimming.
Unknown blood alcohol values	
	Adult male who entered the water at the end of a jetty in uncertain circumstances. He had been drinking on the jetty with a friend, but no other information was recorded.
	Adult male who drowned swimming in the sea. He was described as having been drinking and taking valium (diazepam).

Based on the evidence in the available documents, 30 of the 170 deaths (18%) appeared to have a meaningful contribution from alcohol. Blood alcohol measurements were available for 28 of these, all of which were greater than zero. However, for six of the 30 cases where alcohol appeared to have contributed, the body was decomposed, and this may have resulted in misleading blood alcohol measurements. Of the cases in which alcohol appeared not to have contributed, the blood alcohol was either zero or not known in all cases except those for which the body was decomposed.

Excluding cases which either had a decomposed body or for which the blood alcohol levels were not known, 21% (22 of 105 cases) of cases appeared to have been caused, at least in part, because of drinking associated with the activity. The blood alcohol levels for these cases ranged from 0.020 g/100ml to 0.375 g/100ml. They are summarised in the right hand columns of Table 3.15.

Using those cases with valid blood alcohol levels, the apparent involvement of alcohol varied considerably depending on the incident type, being highest (30%) for recreational incidents, 13% for suicide cases and zero for occupational cases. The percentages differed if all cases were included, but those based only on cases with known, reliable blood alcohol measurements are likely to be more accurate (Table 3.17).

Table 3.17: Involvement of alcohol by incident type for drowning cases only – all cases and cases with valid values, case count and per cent; Australia (excluding Queensland), July 2000–June 2001

Incident type	All cases		Cases with valid values[a]	
	Case count[b]	Per cent alcohol[c]	Case count[b]	Per cent alcohol[c]
Recreational	76	20%	44	30%
Incidental	44	16%	34	15%
Deliberate self-injury	28	11%	15	13%
Occupational	5	0%	3	0%
Other and unknown	17	29%	9	22%
Total	**170**	**18%**	**105**	**21%**

(a) Excludes cases with significant body decomposition and cases with unknown blood alcohol values.
(b) Case count of cases of this incident type.
(c) Percentage of cases of this incident type that arose at least in part because of alcohol use.

Comparison to national deaths data: English et al. (1995) attributable fraction and the ABS 'drug-related' deaths flag

Attributable fraction from English et al. (1995)

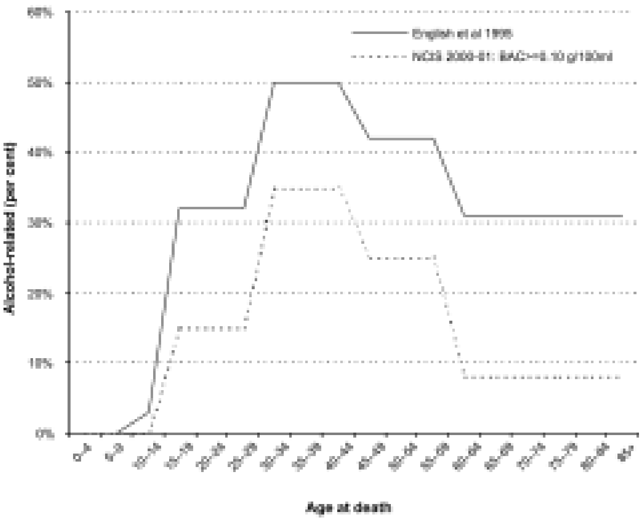
The assessment of NCIS data reported in this chapter provides a basis for a preliminary assessment of the attributable fraction for alcohol and drowning provided by English et al. and summarised in Table 2.1. In effect, the attributable fraction attributes to alcohol all 'accidental drowning' deaths in which blood alcohol level was 0.10 g/100ml or higher, and specifies age-specific and all-ages proportions of drowning deaths for which this BAC level is assumed to be present. NCIS data provide a direct basis for comparing these assumed proportions of drowning in which alcohol is present to proportions calculated using data for recent drowning deaths in Australia.

The solid line in Figure 3.2 shows the age-specific proportions presented by English et al. (1995) as drowning attributable to alcohol, as cited in Table 2.1. Note that these are proportions of cases in which BAC is 0.10g/100ml or higher. The dashed line in Figure 3.2 represents age-specific proportions of drowning cases in NCIS for which blood alcohol data were available and had a value of 0.10g/100ml or higher.

As noted elsewhere, these data are for Australia excluding Queensland. Both data sources have been reported in terms of the age bands distinguished by English, Holman et al. (1995). The all-ages proportions of drowning attributed to alcohol by these two sources are: 34% (English, Holman et al. 1995) and 18% (NCIS >=0.10g/100ml).

The NCIS data suggest that a high level of alcohol (0.10g/100ml or higher) is present less frequently among recent drowning deaths in Australia than was the case for the cases reported in the study referred to by English, Holman et al. (i.e. drowning in North Carolina in the early 1980s).

Figure 3.2: Proportions of drowning deaths which are 'alcohol-related' (defined as BAC >=0.10g/100ml) by age-group according to attributable fractions from English et al. (1995) and NCIS 2000–01 (Australia excl Qld)



Note: horizontal lines represent the proportion for each age group distinguished by English et al. (1995).

‘Drug-related’ flag in ABS deaths data

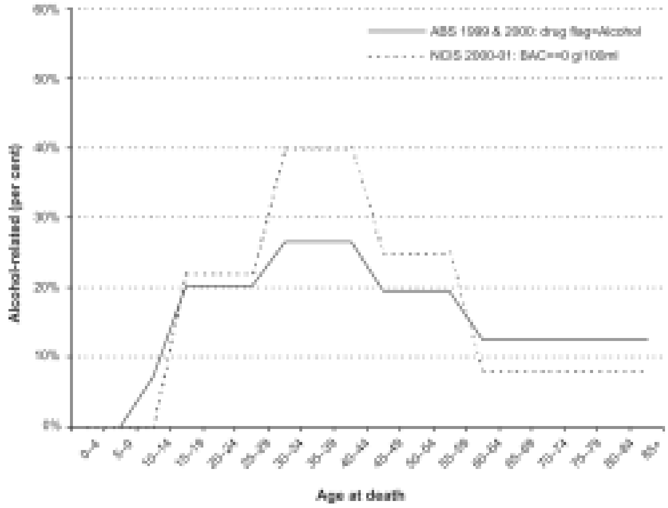
The assessment of NCIS data also provides a basis for assessing a ‘flag’ item in the file of mortality data provided by the ABS. The item is designed to indicate ‘drug-related’ deaths. The item flags deaths ‘related to’ alcohol, tobacco, other drugs, and combinations of these three types of substance.

Interpretation of this item has been difficult. The conceptual basis and coding criteria for its use have not been published, and we are not aware of validation studies. Advice from ABS officers indicates that the flag is given a value referring to alcohol in circumstances likely to be relevant to this project (e.g. if records seen by the coder while establishing the UCoD indicate a BAC above zero) and also in some other circumstances (e.g. if records refer to certain diagnoses, such as alcoholic cirrhosis). Because of this uncertainty the flag item was not used in the analysis of mortality data reported in Chapter 2.

Figure 3.3 shows the proportions of drowning deaths that are identified as being related to alcohol according to our assessment of NCIS data and according to the ABS flag item. NCIS proportions are calculated as the number of drowning cases with any BAC value above zero divided by all drowning cases in which information was available on whether alcohol was present. ABS proportions are calculated as the number of drowning deaths where the Drugs flag has any value mentioning alcohol (i.e. 2, 4, 6 or 7) divided by all drowning deaths. As noted above, the NCIS data accessible for this project excluded Queensland deaths, and the same restriction has been applied to the ABS data shown in the figure. The NCIS data are for the year from July 2000. ABS data for part of this period were not available at the time of writing, and the ABS data used for Figure 3.2 are deaths registered in 1999 and 2000.

The two sources reveal fairly similar age-specific proportions of drowning deaths that involve alcohol (the ABS flag item gives lower values at mid-adult ages). The all-ages proportions of drowning attributed to alcohol by these two sources are: 21% (NCIS >0 g/100ml) and 16% (any ‘alcohol’ value of the drugs flag). Further assessment, based on data for the same period

Figure 3.3: Proportions of drowning deaths which are ‘alcohol-related’ by age-group according to NCIS (2000–01; BAC>0) and ABS Drugs Flag (1999 and 2000; all values mentioning alcohol): Australia except Queensland



Note: horizontal lines represent the proportion for each age group distinguished by English et al. (1995).

and preferably including case linkage, is required to establish whether the flag item provides a measure of alcohol related drowning equivalent to that which can be derived from direct assessment of NCIS data. The preliminary assessment possible at present suggests that prospects for this are quite good.

Non-drowning deaths arising from recreational aquatic activity

The previous two sections described deaths due to drowning. About forty per cent of these incidents (76 deaths) occurred during recreational aquatic activity. An unknown number of the 112 *Open* drowning deaths occurred in association with recreational aquatic activity. In addition to these drowning deaths, nine non-drowning deaths that were associated with recreational aquatic activity were identified. Seven of these were *Closed* cases (although the other two became *Closed* during the current analysis).

The nine cases occurred in South Australia (four), New South Wales (two), Victoria, Western Australia and the Northern Territory (one each). Three deaths involved persons attacked by sharks while the victim was surfing or swimming. Two deaths occurred in the same incident when the victims were electrocuted as a result of a catamaran they were maneuvering from the water coming into contact with high voltage overhead wires. The other four deaths occurred in different incidents – a pillion passenger on a personal water craft sustaining fatal head injuries when the craft hit a partially submerged rock; a scuba diver dying as a result of a vascular gas embolism following a rapid ascent; an elderly man who fell over on a recreational fishing boat and sustained serious chest injuries from which he later died; and a fisherman who fell out of his dinghy on a river and sustained fatal abdominal injuries when the boat ran over him in the water.

Blood alcohol values were only available for two of the cases (the blood alcohol value was zero in both cases), but the information available did not suggest that any of the incidents were associated with alcohol use.

Discussion

The NCIS as a source of information on drowning deaths

The results from this analysis suggest that nearly all drowning cases are reported to the NCIS, and that these can be identified through the use of the Primary and Secondary Mechanism fields (looking for cases coded to '*J2: Drowning and immersion*') and the Cause of Death fields (searching for the text strings 'immers' and 'drown').

Deaths other than External Cause deaths should be included in any search for drowning deaths, because at Notification about 10% to 15% of drowning deaths are not recorded as External Cause, and at Completion there are still about 5% of deaths that are not recorded as External Cause.

It is difficult to assess the effect that a lack of information on cases might have had on identifying drowning deaths and adequately understanding how they occur. One incident involved the deaths of two persons, apparently both from drowning, when they were washed off rocks. One of these persons, whose body was eventually recovered, was included as a case, but the other person was not identified through any of the searches. This person's body may not have been recovered, but it is reasonable to assume that the person also drowned. Presumably the case is either still *Open* but there was insufficient information to link the case to the known case, or has not been reported to the NCIS. As mentioned earlier in the Chapter, there were also two deaths where the only suggestive information was that the persons had been fishing at the time of the incident (as indicated by the Activity code). These cases were *Open* at the time of data extraction and not included as drowning cases as the Mechanism and Cause of Death fields were empty. Later review of these cases for another reason identified them as drowning deaths because the cases had been *Closed*, and information on Mechanism and Cause of Death added, since the data had been extracted for this project. Therefore, it is clear that there were some drowning deaths that were not identified because the case was still *Open* and there was insufficient information in the NCIS to allow the deaths to be identified as being due to drowning. This problem is likely to be even more of an issue for recreational aquatic deaths that did not involve drowning.

We restricted the main analysis to *Closed* cases in order to minimize bias due to missing information. However, even many *Closed* cases lacked adequate documentation, either because the documents were not on the NCIS site or the documents that were present contained inadequate information. Nevertheless, detailed information **was** accessible for many cases. The identified differences in document presence and content between jurisdictions indicate both the possibilities for the NCIS system and the need for improvement in some areas.

The NCIS as a source of information on deaths related to recreational aquatic activity

The vast majority of deaths due to recreational aquatic activity in Australia are due to drowning. Using only *Closed* cases, all but seven (4%) of the relevant cases were due to drowning. The discussion in the previous section on drowning deaths therefore covers most of the issues related to recreational aquatic activity.

The NCIS as a source of information on alcohol's involvement in drowning deaths and deaths related to recreational aquatic activity

The NCIS has been found to provide information on alcohol involvement in the majority of drowning cases, with blood alcohol values available for 70% of cases, and some information on alcohol use or lack of use available for 72%. The quality and level of detail of the information varied considerably between documents of the same type, even within the same jurisdiction, and varied considerably between document types and between jurisdictions. Of particular note were the few cases in which alcohol was not involved and for which there was a definitive statement (in either the police report or finding) about the lack of involvement of alcohol. There were no instances where information on alcohol use, or lack of use, contradicted blood alcohol values. However, a lack of detailed information on the timing, circumstance and amount of alcohol use restricts the ability to properly understand the circumstances, assess the role that alcohol may have played, and use this information to target areas for prevention and plan intervention activities. Only one case was identified in which alcohol use in persons other than the deceased person was obviously involved in the incident (this involved a motor vehicle incident in which both the driver and passenger in the car had been drinking heavily and both died when their car ran off a boat ramp into the water). Information on alcohol use by other persons involved in the fatal events considered here was not usually recorded in available documents, although it was present in a minority of cases. The drug and alcohol module that is being incorporated into the standard police investigation pro-forma, which is currently being developed for use in association with the NCIS might address the current shortcomings in the available data.

The role of alcohol in drowning deaths and deaths related to recreational aquatic activity

The results from this study suggest that alcohol contributes to approximately 21% of fatal drowning incidents. The contribution is estimated to be highest for people engaged in recreational aquatic activity (about 30%) and lower in drowning due to suicide (15%). None of the occupationally-related drowning deaths were associated with alcohol, but there were only five such cases.

These results are consistent with those found in other studies, where a contribution from alcohol has been estimated to occur in between 25% to 50% of unintentional drowning deaths (Howland and Hingson 1988; Hingson and Howland 1993), and about 20% to 30% of drowning deaths related to recreational aquatic activity (see Chapter 5, and particularly Table 5.2). None of the non-drowning deaths related to recreational aquatic activities appeared to involve alcohol.

For some circumstances, determining the role of alcohol or the lack of a role of alcohol in a death seems straightforward. However, for other circumstances this determination can be very difficult, and even when the blood alcohol level is very high it may be difficult to know whether an individual person might have survived an incident if they had not been affected by alcohol. These issues are discussed in more detail in Chapters 4 and 5.

Definition issues

This study raised several issues related to definition – what constitutes a drowning death, what constitutes recreational aquatic activity, and what constitutes meaningful involvement of alcohol?

Most drowning deaths appeared to be straightforward to identify. Sometimes there were questions regarding whether the person may have sustained another injury (usually a head injury) that may have contributed to the incident. Sometimes the body was either not recovered or was so decomposed that establishing a definitive cause of death was virtually impossible. However, overall it was usually clear whether or not the person had drowned. More of a concern is the degree of possible involvement of coronary artery disease, and the influence its presence might have on classification. The presence of significant coronary artery disease at the time of the fatal incident appeared to influence the Case Type assigned to a case. It appeared that very similar cases could be classified as either *External Cause* or *Natural Cause*, depending on the weighting given to the coronary artery disease. The justification for this approach is not clear, as persons with ischaemic heart disease who suffer immersion and become hypoxaemic may well have myocardial ischaemia and resultant fatal arrhythmias or infarction as the terminal event. Also, persons who happen to have been in the water at the time of having an ischaemic event will only have the features of immersion at autopsy if the coronary artery disease was not quickly fatal and the person drowned. In such a situation, the person may well have survived if they were not in water at the time. Either way, it seems appropriate to identify these cases as drowning cases. Alternatively, there will be cases (and one was identified in this analysis) where a person dies whilst swimming, and is found floating submerged in the water, but where the death occurred entirely due to ischaemic heart disease, and the typical features of drowning are not present at autopsy because the person died before inhaling much water. In such situations, drowning would not seem to be an appropriate cause of death to apply. Unfortunately, the situation is complicated by other issues, particularly the fact that a person can suffer a so-called ‘dry’ drowning, and have little or no fluid in their lungs. If such a person also had significant coronary artery disease at autopsy, it might be difficult to establish the correct cause of death. These issues need to be taken into account in any comprehensive study of drowning deaths, and may be an appropriate area for consideration by MUNCCI and the Coroners.

The definition of recreational aquatic activity is largely straightforward, and reasonably well encompassed by the aquatic activity codes applied to the *Sports and Active Recreation* category of the Activity field. However, there were several cases identified in this study that proved difficult to classify, sometimes through lack of information, but in other times for theoretical reasons. Examples included a person washed off rocks while looking at scenery at a beach, and persons drinking at a pier who entered the water in uncertain circumstances.

As mentioned previously, issues regarding assessing the involvement of alcohol in an incident are considered in detail in Chapters 4 and 5.

Data errors in the NCIS

In the course of this study, many errors (mainly minor, but some more important or systematic) were identified in the NCIS data. Those that were important for the study were corrected in the data file. The integrity of NCIS data would be improved if a mechanism was available by which the errors and the corrections could be notified to MUNCCI for inclusion in the database. Although there is nothing to stop this occurring on an *ad hoc* basis, it requires effort and planning by the involved researchers and MUNCCI, and it would be useful if such a process became a formal part of major research projects based on NCIS data. This could occur in a similar manner to that currently in place regarding the need for research findings of public importance based on NCIS data to be reported to MUNCCI and the Coroners at the earliest appropriate opportunity.

4 Emergency department surveillance

Introduction

This chapter discusses the potential feasibility and value of collecting data on alcohol relatedness as part of emergency department (ED) surveillance of drowning and near drowning cases. Several issues are considered:

- The context of ED surveillance for alcohol relatedness among immersion cases;
- The meaning of 'alcohol relatedness';
- Emergency departments as sites for injury surveillance;
- Collecting ED data on immersion cases; and
- Currently available ED data sources.

Consideration of the second and third issues was based on work undertaken by NISU. We have referred, in particular, to a manuscript report edited by one of us (Harrison) entitled *Measuring and characterising injury in Australia,* and to the NISU technical report *Alcohol-related injury and young males* (Steenkamp, Harrison et al. 2002).

Context

The concept of an injury pyramid is well established. Considering injury generally in Australia, for each death there are about 50 hospitalisations (the precise ratio depends on definitions) and still more attendances to EDs. An even greater number of injury cases result in visits to general practitioners (GPs). For example, published estimates of the ratio of injury cases seen at GPs to cases seen at Australian EDs range from 1.2:1 to 2.8:1 (McClure 1994; Day, Valuri et al. 1997). Many injury cases (mainly of low severity) do not attend either EDs or GPs.

In contrast, for drowning and near drowning, about two hospital separations occur for every drowning death. In the financial year 1999–00, about 240 deaths in Australia were coded to ICD-10 codes W65–W74 (*Accidental drowning or submersion*). In the same financial year, 563 hospital separations due to injury were coded to a similar range of ICD-10-AM codes (Helps, Cripps et al. 2002). A recent report on persisting morbidity among hospital separations found that of about 831 separations related to near drowning identified for the 1997–98 financial year, around one in 14 ended with the death of the person (Steenkamp 2002). In contrast, fewer than one in 100 hospital admissions for injury and poisoning of all types ends with death (Cripps, Steenkamp et al. 2002).

These data indicate a high case fatality rate associated with immersion events when compared with other types of injury. This approach to estimating case fatality presumes that all relevant cases (or a large proportion of them) either die, or are admitted to a hospital. This might be true if a narrow definition is used (eg. cases of immersion involving loss of consciousness). If a broad case definition is used (eg cases involving rescue from water) then it would not be true.

Case definitions of drowning, near drowning, immersion and related terms have been the subject of debate and are not well established.[6] As discussed in Chapter 2 and reported in the literature, commonly used ICD 'drowning' codes do not identify all deaths from drowning (Smith and Langley 1998), nor all hospitalisations for near drowning (Steenkamp 2002). Any ED surveillance data system for immersion or near drowning should pay close attention to the definition of relevant cases.

Collecting data on the role of alcohol among immersion cases presenting to emergency departments needs to be considered in the context of obtaining data on alcohol relatedness for all types of outcomes following immersion events. Table 4.1 presents a summary of various outcomes and potential avenues of collecting data on cases and alcohol relatedness.

Alcohol relatedness

This section is largely based on the NISU technical report *Alcohol-related injury and young males* (Steenkamp, Harrison et al. 2002).

The concept 'alcohol relatedness' or 'alcohol involvement' is not well-defined. This is illustrated by the different methods used to describe alcohol involvement in Table 5.2.

In current literature, the term 'alcohol relatedness' is often used to refer to evidence that an injured person had consumed alcohol in the period leading up to an injury event. This 'acute' alcohol use is often stated as alcohol consumption in the six/nine/twelve hours before the injury event and is measured by blood or breath alcohol levels and/or self-report by patients, depending on ethical considerations and resources available.

'Alcohol relatedness' can also refer to alcohol use by other parties involved in the injury event, such as an assailant or the driver of another vehicle involved in a crash. Information on this type of alcohol-relatedness is rarely collected routinely, except perhaps in specialised data systems. The concept 'alcohol relatedness' can also incorporate other aspects regarding alcohol use, such as usual drinking patterns and/or alcohol dependence. This report makes minimal comment on alcohol use by other parties involved in immersion events or on drinking patterns in relation to immersion, mainly because of a lack of information in current literature.

Another aspect to consider is whether alcohol relatedness/involvement only refers to the 'presence of alcohol' or to whether alcohol 'contributed to' or 'caused' the injury event because of impairment on the part of the relevant parties involved. It is often problematic to demonstrate that intoxication leads to impairment, and potentially confounding factors (e.g. polydrug use, how learned the activity is, hangover effects, and psycho-physiological consequences) should be considered.

A major challenge in regard to establishing and understanding (causative) relationships between alcohol use and injury is the use of meaningful and accurate measures of intoxication and impairment. There is a danger that poor representations of intoxication will be used (e.g. self-report or estimated blood alcohol levels). There are also temporal problems with measurement, i.e. time delays between injury and measurement. Self-report of alcohol use in those who use alcohol in a hazardous and harmful way is generally truthful if the interview is conducted in a clinical research setting, the respondent is alcohol-free, and there is an assurance of confidentiality (Sommers, Dyehouse et al. 1997).

Routine data, especially those on fatalities and hospitalisations, are the most substantial sources of data on injury in Australia. Identification of a sub-set of the injury cases as 'alcohol related' is not straightforward. Broadly, two approaches can be taken. One is to assess alcohol-relatedness case by case. The other is to estimate the fraction of cases (of all injuries, or of particular types) and use available evidence to estimate the proportion of that type that can be attributed to alcohol. The attributable fractions approach was introduced in Chapter 2. Case-by case identification was used in Chapter 3 and is outlined here.

---

6 Definitions were considered by the Epidemiology of Drowning task force of the World Congress on Drowning, Amsterdam 26-28 June 2002 (www.drowning.nl).

Table 4.1: Potential ways of collecting data on alcohol relatedness for various outcomes following immersion events

Type of outcome	Ascertainment of (near) drowning cases	Potential to ascertain presence of alcohol (levels, or cases exceeding a threshold)
1. Deaths (About 400 per year) [(a)]	National collection processes are in place, i.e. both through the ABS and NCIS. Ascertainment is estimated to be good for ABS data, but still needs to be established for NCIS cases (see Ch. 3).	Blood alcohol levels are determined for many cases. Reasons for non-assessment include delays between immersion event and death (e.g. if deceased attended a hospital prior to death), which appears to be uncommon; delays between death and the time of testing; and the body not being recovered The potential for ascertainment of alcohol levels at time of death is high, and good for establishing which cases had levels exceeding some set threshold (e.g. the legal limit for driving a vehicle).
2. Hospitalised cases (About 6 to 7 hundred 'incident' cases per year) [(b)]	National collection process in place, i.e. through the AIHW's National Hospital Morbidity Database (NHMD). Ascertainment is thought to be good.	Blood or breath alcohol levels are not determined as a routine practice. Reasons for non-assessment include ethical and practical considerations, and delays between immersion event and hospital admittance. Alcohol relatedness is sometimes recorded in notes and appears in the NHMD as relevant ICD codes recorded in diagnosis fields. The potential for general ascertainment at national level of alcohol levels for admitted cases is low. Specific studies at selected sites may be possible. Trauma registers might provide a basis for obtaining information on the small numbers of relevant cases (though only some registers include immersions).
3. Cases presenting to EDs (Case counts not known)	There is no national collection of such cases, which is poorly defined difficult to quantify, and probably overlaps with (4), especially for minor cases.	Blood alcohol levels are not determined routinely for ED cases, though legislatively-based collection has been required for some case types in some jurisdictions [eg motor vehicle drivers (O'Connor and Trembath 1995)] A few investigators have studied blood alcohol for samples of injury cases presenting to an ED (McLeod, Stockwell et al. 1999; Roche, Watt et al. 2001) Recent alcohol consumption was assessed by interview and breath tests. Ascertainment rates were high in the context of these studies, which provided dedicated project staff for collection, and surveyed modest numbers of cases (ie hundreds, compared with as total number of ED injury attendances which is likely to be over 1 million per year). Cost, acceptability and other issues relevant to the feasibility of applying these methods for routine collection are not known, but are likely to present a considerable barrier.
4. Cases presenting to GPs (Case counts not known)	No national collection of such cases exists. A sample survey system is in operation (Britt, Sayer et al. 1999). However, incidence of immersions is low in relation to survey power.	Blood alcohol levels are not determined routinely. Numbers of relevant cases are likely to be small. The potential for ascertainment of alcohol levels on a national level is low.
5. Cases whether or not presenting to the health sector. This includes rescues by life savers or bystanders. (Case counts not known. 'Rescues' might be measurable)	There is no national collection of such cases, which are poorly defined and probably difficult to quantify.	Blood alcohol levels are not determined routinely. The potential for ascertainment of alcohol levels on a national level is low (perhaps less so for formal rescues). Special studies would be possible.

(a) Annual number of drownings will vary according to which definition of drowning is used (see chapter 2)
(b) See *Persisting morbidity among hospitalisations for near drowning, Australia 1997-98* (Steenkamp 2002)

It is, in principal, possible to assess injured people, case by case, to determine whether alcohol might have contributed to the occurrence of each injury case. That can be done by obtaining evidence that the injured person, or some other person involved in the event that resulted in injury, had a significant level of blood alcohol at the time of occurrence. Even if case by case evidence of the presence of alcohol is obtained, it does not necessarily imply a causal role (e.g. a car driven by a sober person hits a tree, resulting in injury of an alcohol-affected passenger). However, providing that there is a reasonable level of detail in the available documents, it is often possible to determine that the circumstances of the incident were such that it was likely that the level of intoxication of the person contributed to the injury occurring and/or to the resulting injury being more serious than it might otherwise have been.

In practice, obtaining such information is often difficult. Nevertheless, collection of information about recent alcohol consumption by persons presenting to EDs because of injury has been done in the context of some special studies (McLeod, Stockwell et al. 1999; Roche, Watt et al. 2001). These reports show that collection is possible when special resources are available, such as dedicated data collection staff. Transfer of these findings (based on hundreds of cases) to routine collection of BAC data on a mass basis in EDs (ie. to annual case numbers three or four orders of magnitude greater) would be a major undertaking, raising substantial issues of cost, acceptability, quality assurance and other matters.

It is particularly unusual to obtain information on alcohol levels of potentially relevant persons other than the injured person, with the exception of some drivers involved in motor vehicle crashes (O'Connor and Trembath 1995).

Emergency departments as surveillance sites

This section is largely based on an unpublished NISU report *Measuring and characterising injury in Australia* (ed. JE Harrison).

EDs have strengths and weaknesses as sites for surveillance of injury (or other types of case).

Strengths of EDs as surveillance sites include:

- Cases are concentrated at a relatively small number of locations, i.e. about 1.5 million injury cases attend approximately 500 EDs in Australia each year and about 50% of cases are seen at the 70 or so of the busiest EDs.
- There is quite widespread willingness to contribute to injury surveillance at these sites, subject to practical considerations and provision of resources.

Limitations are:

- There are not well-established traditions of (nor mechanisms for) collection and coding of data for statistical purposes, particularly at national level (cf. hospital in-patients).
- In keeping with other parts of the health sector, EDs are under cost pressures that limit capacity to engage in what tend to be seen as non-core activities.
- In the absence of widespread and comparable electronic record keeping systems, collection of data concerning ED cases is confronted by practical problems, i.e. a lack of good sampling frames; methods for case identification and data capture and recording which tend to be seen as ancillary to the ordinary work and record-keeping of EDs; and a lack of relevant precedents for collection, transfer and use of data at national level.

It is important to distinguish between two potential purposes for ED injury surveillance data i.e.

1. to measure and monitor injury incidence in a population over time; and
2. to provide a pool of information-rich case records which can be used to describe injuries and their circumstances of occurrence (i.e. for case characterisation).

These two purposes implicate somewhat different data requirements for relevant surveillance systems as outlined below.

- **Measuring and monitoring injury cases**

  For this purpose, the main requirement is that an ED surveillance system should be capable of estimating case incidence rates with sufficient precision to enable significant changes to be detected reliably.

  Such a system requires meaningful and practicable case definitions, and collection mechanisms capable of counting all—or a well-defined sample of—cases meeting the definition that arise in a particular population and time period.

  It is technically feasible to develop a system based on a sample of EDs that would be capable of measuring cases (injury or other) attending EDs. Doing so would be relatively expensive, and would present considerable challenges in achieving and maintaining good data quality.

  An important limitation of ED-based surveillance of injury is that even if a good quality data collection system existed, which was capable of detecting changes in ED case numbers, such changes may not imply change in injury incidence. This is because most injury cases do not attend an ED, and the proportion that are seen at an ED might change for various reasons unrelated to incidence.

- **Characterising injury cases**

  'Characterising' refers to describing specific injury case types and associated factors, preferably in detail. The main requirement for a surveillance system with this purpose is that the system should provide relevant case information of reasonable depth and quality. Description may give insight into causal mechanisms and suggest means for prevention. Cases and sometimes controls can be selected from such pools for case-control studies of injury risk factors. Emergency Departments are potentially a useful source of information to characterise immersion cases, although the circumstances surrounding cases presenting to EDs might not be the same as those surrounding other cases (ie. rapidly fatal cases, and 'near miss' cases in which immersion is not followed by effects likely to prompt ED attendance).

Collecting ED data on immersion cases

Drowning is the best known serious consequence of immersion events. However, it has been estimated that as many near drownings occur as fatal immersions (Nixon, Pearn et al. 1995). Some cases attend EDs, which can thus be considered as a setting for surveillance.

From the point of view of quantitative surveillance, the potential value of ED data would be high if this source enabled measurement and monitoring of a type of water-related injury case not well covered by an existing source. Three broad case types can be distinguished: (1) deaths (drowning); (2) severe non-fatal (eg. near-drowning with loss of consciousness; or evidence of persisting harm); and (3) non-severe, non-fatal.

(1) While some drowned persons are brought to EDs, and some drowning deaths occur there, most do not. ABS mortality data and the NCIS provide a better basis for surveillance of drowning.

(2) Severe non-fatal cases are likely to be brought to an ED, but they are also likely to be admitted to hospital. Hospital separations data provides an existing source for basic surveillance of these cases, though information about circumstances of occurrence is not sufficiently detailed for some purposes (Steenkamp 2002). More extensive information on these cases could be collected at EDs. However, numbers of relevant cases (several hundred per year) are small in relation to all ED cases (millions per year). Interests concerning this uncommon case type would be unlikely to have much influence on the design of a general-purpose ED data system. Also, more information is likely to be known about these cases by the time of discharge from hospital than at the time of presentation to an ED. Consequently, a potential route to better information on severe non-fatal cases would be based on case-note review, using existing hospital separations data as finding aids. A second route would be for trauma registers to include near-drowning cases uniformly (only some registers do so at present), or to develop a special-purpose register.

(3) Cases that are neither severe nor fatal are the least well defined type. While some such cases attend an ED, the fraction doing so is quite uncertain (depending on the definition used the fraction may be small), and the cases presenting may not be a representative sample. While data presently collected at EDs on such cases warrants examination, other investigations would be required to quantify the occurrence of this type of case, and to determine the representativeness of the cases seen at EDs.

Currently available ED data sources

The main relevant Australian ED data collections (those held by the Victorian Injury Surveillance and Applied Research system, VISAR, and the Queensland Injury Surveillance Unit, QISU) do not include data items designed to identify alcohol relatedness. Text fields might include mention of alcohol in some instances but this is not likely to provide a satisfactory basis for determining alcohol-involvement. Routine assessment of alcohol involvement of injury has been attempted in some EDs in the USA and (on a limited basis) in Australia. Special studies show that it can be done on a small scale, given sufficient resources (McLeod, Stockwell et al. 1999; Roche, Watt et al. 2001). Legislative provisions in Australian jurisdictions variously require blood samples to be taken in EDs to allow blood alcohol measurement for certain persons involved in motor vehicle incidents (O'Connor and Trembath 1995).

5 Literature review

Introduction

The chapter considers information on recreational aquatic activity that is available from the published literature. It briefly considers what is known about drowning, near drowning and other injuries arising from recreational aquatic activities in Australia. The physiological effects of alcohol that contribute to drowning and other aquatic-related injury are described, followed by consideration of literature on the extent of use of alcohol in association with recreational aquatic activities, and studies on public perceptions regarding the role of alcohol in injuries related to recreational aquatic activity. Next, a review of what is known about alcohol's contribution to drowning in general, and serious and fatal injury arising from recreational aquatic activities in particular, is presented. Finally, prevention activities are reviewed.

Scope

Recreational aquatic activities are the focus of this section. These are defined as activities explicitly related to water that are undertaken for fun, pleasure or amateur sport. Typical examples include recreational swimming, fishing, sailing, boating and diving. ('Diving' in this report includes both diving into water and underwater diving such as scuba diving but, unless otherwise specified, refers to diving into water, such as occurs in swimming pools). All relevant places are included, such as large bodies of salt or fresh water, rivers, and backyard and local swimming pools. Deaths which occur when the water is incidental to the activity at the time (e.g. a toddler playing next to a pool or dam, someone walking along a pier or near a river, and a car travelling on a bridge across a river) have been excluded as much as possible, as have activities which would normally involve water but which are not recreational (e.g. having a bath, undertaking professional fishing, or using a boat for transport purposes as part of usual daily activities). In practice, it was sometimes difficult to exclude all unwanted cases because of the way the data were presented in the available papers and reports.

Recreational aquatic activity in Australia

There is not a lot of information on the extent of recreational aquatic activity in Australia. The most recent such information suggests that swimming is the most popular activity, followed by surf sports, fishing, and water skiing and power boating. This information comes from a national telephone survey conducted for the Australian Sports Commission from February to November 2001. This survey was restricted to persons 15 years and older and covered only active participation. Persons could nominate more than one activity, and the presented results on individual activities don't allow an assessment of overall participation in at least one of a group of activities. The number and proportion of people involved in specific recreational aquatic activities are shown in Table 5.1.

Table 5.1: Active participation in recreational aquatic activities; Australian population aged 15 years or more: number and per cent

Activity	Number ('000)	Per cent
Aquarobics	142.1	0.9%
Canoeing/kayaking	102.1	0.7%
Fishing	365.0	2.4%
Sailing	150.3	1.0%
Scuba diving	79.4	0.5%
Surf sports	366.6	2.4%
Swimming	2,415.5	16.0%
Water skiing/powerboating	176.5	1.2%

Source: (Australian Sports Commission 2002)

These percentages are considerably lower than those reported from comparable surveys conducted in the United States (described below). The reasons for the large differences are not known, but at least some of the difference may arise from the definition of 'active participation' that was used in the Australian survey. It is likely, therefore, that the true participation rate in Australia, particularly in recreational boating and swimming, is considerably higher than suggested by the information from the survey.

Injury associated with aquatic activity

The main types of injuries associated with swimming, recreational boating and other recreational aquatic activity are:

- drowning whilst swimming, boating, fishing or underwater diving;
- other injuries while boating; and
- cervical spine injuries from diving into water.

The non-drowning injuries include head injuries, internal injuries, spinal injuries and barotrauma. Hypothermia also occurs, but in fatal occurrences in cold water it is often very difficult to distinguish between death due to drowning and death due to hypothermia.

'Drowning' is defined as death from suffocation by submersion in a liquid, usually freshwater or seawater. 'Near drowning' is submersion in a liquid where the victim survives, at least in the short term (Modell 1981). 'Immersion' is used to describe these occurrences.

From 1992–1997, 2,637 people drowned in Australia. Two hundred and ninety two drowning deaths followed boating incidents. Another 1,551 'accidental', non-boating drowning deaths occurred—346 in an ocean or estuary, 162 at a surf beach, 262 at non-tidal lagoons and lakes, 90 while fishing and 56 during diving (Mackie 1999). Preliminary data for 2000/2001 suggest a decline in the number of drowning deaths in Australia since then, with 269 drowning deaths in the 12-month period. Ninety-two of these related to swimming, 46 to watercraft incidents, 16 to fishing and 14 to diving (Royal Life Saving Society of Australia 2001).

In 1998/1999, 23 persons sustained a serious spinal cord injury in an aquatic environment (9% of all persons sustaining spinal cord injuries in Australia during that 12 month period), including seven who were dumped by waves while surfing or swimming; six who were diving into swimming pools; six who were diving, or fell, into a river or lake; and three who hit their head on sand as they dived into the surf (O'Connor 2000).

Physiological effects of alcohol

There are a number of factors that increase the risk of injury for persons involved in swimming and other water-related activity when combined with alcohol. These include factors that:

- impair the judgement of when to engage in the activity;
- decrease the normal ability to engage in those activities;
- increase the chances that the person will be injured while undertaking the activity; and/or
- increase the risk of sustaining a severe injury or not surviving the injury.

In terms of recreational swimming, factors apart from alcohol that are known to increase the risk of drowning or near drowning include swimming inexperience, swimming at night, swimming alone, swimming in dangerous water conditions and swimming at unpatrolled beaches. For boating, factors other than alcohol that increase the risk of fatal injury include not wearing a life jacket, boating in dangerous water conditions, operator inattention, operator inexperience and careless/reckless operation (United States Coast Guard 2001).

The psychological and physiological effects of alcohol have the potential to increase the likelihood of exposure to these higher risk situations. These include impairing:

- judgement by affecting cognitive processing, thereby increasing the likelihood of persons choosing to be, or not avoiding being, exposed to higher risk situations;
- balance, vision and coordination by affecting central nervous system processing, thereby increasing the risk of falling overboard, falling heavily, and of being involved in a collision;
- physiological responses by causing blood vessel dilatation, which increases the period of time someone may choose to swim in cold water, thereby increasing the risk of sustaining hypothermia; and
- labyrinthine function and laryngospasm, thereby decreasing the chances of survival if in the water, because of effects on swimming ability and an increased risk of hypothermia (Gooden 1972; Gooden 1984; Howland and Hingson 1988; Howland, Mangione et al. 1990; Howland, Smith et al. 1993; Bross and Clark 1995).

In addition, alcohol has been found to impair the ability of divers to perform entry dives into shallow water (Perrine, Mundt et al. 1994).

Interpreting information on alcohol use and alcohol contribution

The previous section has presented reasons why, a priori, alcohol may increase the risk of immersion or other serious injury during aquatic recreational activity. However, several factors need to be considered when assessing the evidence for a causal or contributory role for alcohol in serious injuries arising from aquatic recreational activity.

Firstly, as mentioned in Chapter 4, alcohol may not necessarily play a causal role in an incident even if it is present. For example, if 50% of drowning swimmers have a blood alcohol concentration (BAC) of greater than 0.08g/100ml, and 50% of non-drowning swimmers also have a BAC greater than 0.08g/100ml, then there is no evidence that raised blood alcohol levels increase the risk of drowning. There may still be an increased risk in this situation if a greater proportion of the drowned swimmers have a very high blood alcohol level compared with non-drowned swimmers, but this would need to be ascertained. Therefore, information on blood alcohol levels in comparison populations is required when interpreting data on a study population (Johnstone 1985).

Secondly, blood alcohol levels can rise after death due to decomposition processes, or fall prior to death due to normal metabolic processes. Therefore, it is important to know the time at which the blood (or other body fluid) used in the test was obtained in relation to when the incident occurred and when the death occurred. Wintemute and coworkers have suggested criteria of death within six hours of immersion and blood being obtained within 24 hours of death (Wintemute, Teret et al. 1990). However, as a general rule, the closer to the time of death that the blood is taken the better, provided that death occurs soon after the injurious incident takes place. More correctly, the blood alcohol level at the time of the injurious incident is the primary measure of interest. Therefore, it is important to obtain information regarding when the blood used for blood alcohol level estimation is taken in relation to both the incident and the death (Johnstone 1985).

Thirdly, many studies describe all drownings, whether intentional or unintentional, thereby including those due to homicide and suicide. Others only cover non-intentional drownings, but include people not involved in aquatic activity, such as those falling into water when not involved in recreational aquatic activity, and drowning resulting from motor vehicle crashes. Some studies include only aquatic activities, but cover all related activities, such as occupational activities, and persons travelling on a boat just for transport purposes. In addition, some studies cover only immersion injuries, whilst others cover all injuries, including physical injuries such as fractures and lacerations, in addition to immersion injuries. Therefore, it is important to focus only on the activities of interest. This analysis is focussed on serious and fatal injuries of any type that result from recreational aquatic activities. However, available data sources, and the predominance of drowning and near drowning incidents, means that most information describes immersion injuries arising from recreational aquatic activities, and available information on recreational diving injuries focuses on injuries to the cervical spine.

Use of alcohol in recreational aquatic activities

Most information on the use of alcohol in association with recreational water activity comes from telephone surveys conducted in the United States (US), either at a national or State level. These surveys have consistently suggested that about 30%–40% (higher in some studies) of people on boats drink alcohol while on board (Howland, Smith et al. 1993). The more important of these studies are reviewed here.

In a national telephone survey of persons 16 years or older in the US, 89% of persons reported having been involved in at least one activity in or near the water in the previous year, with swimming (75%) and boating (72%) being the most common. Of all persons surveyed, 43% reported using alcohol at least once while being engaged in these activities, and 28% reported drinking alcohol on the last occasion they engaged in these activities. Twenty-four per cent of swimmers and 32% of boaters reported having drunk alcohol during these activities at least once in the previous year. Males were more likely to have drunk alcohol, and tended to drink more heavily, than did females. Of those persons who reported drinking alcohol while involved in aquatic activities, 9% reported that they often or always drank, 36% said that they often drank, and 55% that they rarely drank alcohol during those activities. Nearly all the total respondents supported laws prohibiting operation of vessels while intoxicated, but less than 50% of respondents were aware that such legislation was already in place (Centers for Disease Control and Prevention 1993). A similar survey based in only one State found 36% of men and 11% of women reported having drunk alcohol while engaged in aquatic activities (Howland, Mangione et al. 1990).

A more recent survey examined factors that might contribute to the higher rate of drowning in men compared to women. This survey revealed that men engaged in higher risk activities associated with aquatic activities than did women, including being more likely to drink alcohol when they engaged in aquatic activities (33% vs 23%). They are also more likely to drink greater amounts of alcohol and are more likely to drink when swimming alone (15% vs 4%) or at night (38% vs 32%). Of persons who boated without wearing a lifejacket, a higher proportion of men reported having been drinking at the time (44% vs 33%). In addition, men who had drunk alcohol were more likely to swim where there was no lifeguard (26% vs 37%), and to operate or travel in a powerboat without a lifejacket (9% vs 30%), compared to men who didn't drink. The differences were smaller between women who drank and didn't drink alcohol in relation to these circumstances (Howland, Hingson et al. 1996).

In a national telephone survey conducted in the US, 31% of persons who had operated a powered boat reported having done so at least once while influenced by alcohol. This was more likely among males, persons between the ages 25–34 years, and higher educated persons. The authors concluded that, because persons who reported operating a boat while influenced by alcohol also tended to report operating motor vehicles while under the influence of alcohol, strategies used to decrease injuries arising from alcohol-related driving might also be useful to decrease injuries arising from alcohol-related boating. They also suggested there was a need for better monitoring of the use of alcohol while operating powered boats, and that the use of alcohol by passengers needed attention (Logan, Sacks et al. 1999).

Another national US telephone survey examined boating training and experience, and found that 73% of respondents who operated boats had no formal training. Surprisingly, boaters with training were just as likely as those without training to use alcohol (26% to 27%) and not to use personal flotation devices (76% to 79%). It was concluded that these results suggested inadequacies with the available boater training and that boat operators did not properly understand the risks of the activities in which they were engaged. The authors suggested training should cover the risks of alcohol while boating, and be conducted often enough to prevent low risk perceptions recurring (Bell, Howland et al. 2000).

A recent face-to-face interview survey of boat operators in the US found that 12% of recreational boat operators used alcohol while operating the boat, and 35% of crew used alcohol in association with recreational boating. The authors stated that they considered the results probably considerably underestimated the true prevalence of alcohol use (Ciraulo, Smith et al. 2000).

Finally, a State-based US study of boaters interviewed at boat ramps found that about 70% of boaters reported that they had drunk alcohol on boat outings, 47% were carrying alcohol on the day of interview, 75% said that they consumed two or more drinks on each outing at which they drank, and that the prevalence of alcohol use was not affected by boating training or knowledge of laws addressing alcohol use in relation to boating (Glover, Lane et al. 1995).

Other State-based surveys have found similar qualitative results, with swimming and boating being the most common recreational aquatic activities. About 30% of persons reported alcohol use in association with these activities, and about 30% of these alcohol users reporting at least moderate alcohol intake when they do drink, with men consuming more alcohol than women (Centers for Disease Control and Prevention 1990).

One survey of persons involved in boating obtained breath samples from operators and passengers, as part of a larger case-referent study of the role of alcohol in boating fatalities (this study is described in more detail later). The study found that 17% of referents had a non-zero blood alcohol, with 7.4% having a value greater than 0.05g/100ml, 3.4% 0.10g/100ml or greater, and 1.4% 0.15g/100ml or greater (Smith, Keyl et al. 2001).

Public perceptions about recreational aquatic activities and alcohol

There is no published information about public attitude or understanding in Australia of alcohol's involvement in serious and fatal injuries sustained during recreational aquatic activity. Some information is available from the US, where a random mail survey of boat owners found that the respondents reported that it was safe for passengers to drink more than boat operators, and that it was safe to drink more when the boat was at rest compared to when it was moving (Howland, Mangione et al. 1996).

Another national survey in the US, this time by telephone, showed that members of the general public reasonably accurately estimated the proportion of persons who drowned who were legally drunk at the time of the incident, with the study's 'true' result coming from a meta-analysis of studies using data from medical examiners to examine alcohol involvement in fatal non-traffic injuries (Smith, Branas et al. 1999). About half the respondents thought that raising the legal drinking age to 21 had decreased the number of injury deaths, 78% stated that they did not believe that raising alcohol taxes would decrease injury deaths, and 58% supported blood alcohol measurements being taken on all 'seriously injured' persons presenting at hospitals. However, it should be noted that the study wasn't focussed specifically on drowning, and these results relate to alcohol and all injuries. The authors concluded that the public did not have a good understanding of how alcohol-policies can decrease alcohol-related injury, and suggested that the general public should be included in education programs by injury prevention professionals (Girasek, Gielen et al. 2002). A related analysis of the same survey found that the respondents believed that 67% of drownings were preventable (Girasek 2001).

Overall contribution of alcohol to drowning deaths

In their review of alcohol and drowning literature published up to 1985, Howland and Hingson (1988) found that between 25% and 50% of adult persons who drowned unintentionally had used alcohol, but they also called for more information to be collected on alcohol use in involved persons who did not drown (Howland and Hingson 1988). A subsequent review by the same authors of literature up to 1991 found a similar range of values (Hingson and Howland 1993). Several relevant studies have been published since then, and their results remain consistent with the Howland and Hingson reviews. For example, a meta-analysis of non-traffic injuries found that 34% of drowning victims had a blood alcohol level of 0.10 mg/100ml or greater, very similar to the percentage found for drivers killed in motor vehicle crashes on public roads (33%)(Smith, Branas et al. 1999). This result was similar to that found in a recent study of unintentional drowning in King County, Washington State, which examined the role of alcohol and medical care in trends in unintentional drowning. Of the identified drowning victims in the King County study, 69% had useable blood alcohol readings and, of these, 62% had no alcohol in the blood, 9% had a blood alcohol above zero but less than 0.10 g/100ml, and 30%

had a blood alcohol greater than or equal to 0.10 g/100ml (Cummings and Quan 1999). There is little information on other causes of death or serious injury, apart from drowning and near drowning, arising from recreational aquatic activity (although some information on cervical spine injuries sustained in recreational diving is presented later).

Of Australasian studies, the first study of note covered all non-intentional drownings that occurred in the greater Sydney area during 1962–1964 inclusive. Drowning deaths associated with motor vehicle incidents appear to have been excluded. Ninety-one (56%) of the 163 eligible deaths occurred during recreational aquatic activity, with swimming (48%), boating (26%), surfing (11%) and rock fishing (10%) the most common activities being undertaken by the victims. A minimum of 7%–13% of persons was reported to have been intoxicated, and this was considered by the author to be a probable underestimate. No information on alcohol involvement was presented regarding deaths occurring due to recreational aquatic activity was presented (Adams 1966).

A study of all non-intentional drownings in Geelong from 1959 to 1983, using blood alcohol values described as 'valid for the time of death', reported that 31% of male victims 15 years of age or older had blood alcohol levels of 0.08g/100ml or greater. Fifty-one per cent of men aged 30–64 years had blood alcohol levels of 0.08g/100ml or more, and 42% of these people with raised blood alcohol levels had levels over 0.3 g/100ml. None of the 13 females had blood alcohol levels of 0.08g/100ml or more (Plueckhahn 1984).

A similar study based in Auckland, New Zealand, found that of 150 accidental drowning victims (129 males), over half had consumed some alcohol and 37% of these (about 20% of all persons who drowned unintentionally) had levels over 0.10 g/100ml. Inclusion criteria for the blood alcohol measurements were not detailed (Cairns, Koelmeyer et al. 1984).

A more comprehensive New Zealand study of all drowning deaths from 1992–1994 inclusive of persons 10 years or older was based on coroners' files. Forty per cent of those tested within 48 hours of body recovery had some alcohol detected in the blood, and in 24% the level was 0.10 g/100ml or more. However, blood alcohol levels were only available for about one third of all deaths for which files were found. The authors concluded that about 30%–40% of all drowning victims had at least some alcohol in their blood at the time of the incident, and in 17%–24% the level was 0.10 g/100ml or higher (Warner, Smith et al. 2000).

A case series of surf lifesaving resuscitations in Queensland from 1973–1986 suggested that a minimum of 21% of resuscitated persons had consumed at least moderate amounts of alcohol immediately prior to the incident. However, interpretation of the actual role of alcohol is difficult because the identification of alcohol consumption was based on the smell of alcohol on the breath of the person being resuscitated, and the authors stated that the 21% was probably an underestimate. Only 70% of the resuscitations were for immersions (another 7% were for other injury of some sort), and 89% of the alcohol-positive cases were for immersion. Seventy per cent of the immersion victims survived (Fenner, Harrison et al. 1995).

Contribution of alcohol to recreational aquatic activity injury

Most potentially useful studies include cases who were injured in circumstances other than recreational aquatic activities, as mentioned previously. However, many report some results that are relevant to the consideration only of recreational aquatic activity. The information on alcohol involvement is of varying quality, from poor to very good. The useful results from the more relevant of these studies are reviewed briefly here, presented separately for swimming, boating and diving. The information for swimming and boating is summarised in Table 5.2, and that for diving in Table 5.3.

Recreational swimming

The Australian study of all non-intentional drownings in Geelong from 1959 to 1983 reported that sixteen of 35 men (46%) who drowned while engaged in recreational swimming had BAC more than zero, and 20% had a BAC greater than or equal to 0.08g/100ml (Plueckhahn 1984). An earlier analysis of a subset of the study subjects reported that 28% of the non-intentional drownings occurred during recreational swimming and 31% during boating (probably mostly recreational) (Plueckhahn 1972).

The Queensland case series of surf lifesaving resuscitations reported that alcohol use was suspected in 21% of the recreational swimmers (Fenner, Harrison et al. 1995).

The Canadian Red Cross publishes an annual report on all drowning deaths in Canada. The 1999 report, using blood alcohol values but with no information about inclusion or exclusion criteria of tests, reported that 63% of recreational swimmers who drowned had BAC more than zero, and 53% had BAC greater than 0.08g/100ml (Canadian Red Cross Society 2000).

A study of all non-intentional drownings in active male United States' soldiers considered the role of alcohol and other risk factors. Although all non-intentional drownings were included, only 11% were due to occupational activities and 6% to an unintentional fall into the water. The remaining 83% were due to recreational activities, particularly swimming (40%), boating (15%) and diving (6%). Involvement of blood alcohol was determined only by its mention in investigative reports, no blood alcohol values were presented, and information on blood alcohol was missing in 47% of cases. Of those cases for which blood alcohol information was available, 58% had blood alcohol mentioned as having contributed, and 48% of these (28% of those with available blood alcohol levels) were documented to have been drinking heavily. However, there was no information on alcohol levels stratified by activity at the time. The authors noted that alcohol intake was associated with a number of other risk factors for drowning, such as 'reckless behaviour', 'violation of safety rules', 'swimming in an unauthorised area' and 'diving into an unknown depth' (Bell, Amoroso et al. 2001).

A study of all 'accidental' drownings in Denmark from 1989–1993 inclusive identified 147 drowning deaths associated with recreational aquatic activity. Boating accounted for 64% of these and swimming for another 26%. Information came from the medico-legal death certificates, which included a summary of circumstances of the death. Formal blood alcohol measurements were usually not available. The study found that 22% of decedents were under the influence of alcohol at the time of the incident, including 32% of swimmers (Steensberg 1998).

A South African study of all drowning deaths from 1980–1983 inclusive reported that 55% of the 87 persons who drowned while engaged in recreational swimming had blood alcohol levels greater than zero. However, there was no information on the criteria used to include or exclude blood alcohol estimations (Davis and Smith 1985).

A study of all 293 drowning deaths in a Californian county from 1974–1985 inclusive used strict criteria for useable blood alcohol concentrations—persons who died within six hours of immersion and whose blood was taken within six hours of death. Of the 40 persons who were engaged in recreational swimming, 63% had BAC more than zero, 55% had BAC over 0.05g/100ml, and 40% had BAC more than 0.10 g/100ml (Wintemute, Kraus et al. 1988).

A Maryland study of all 'accidental' drownings in 1972 presented data on alcohol levels in a subset of 45 persons who had drowned in Baltimore from 1968–1972 inclusive and for whom apparently appropriate blood alcohol measurements (persons for whom the body was submerged less than 12 hours) were available. Eleven of the fourteen swimmers (78%) had blood alcohol levels above zero, and 50% had blood alcohol levels greater than 0.15g/100ml (Dietz and Baker 1974).

Recreational boating

Most serious or fatal injury related to boating is due to immersion. For the United States, there were 701 recreational boating-related deaths in 2000. Seventy four per cent of these persons drowned, and it was suggested that 86% of the people who drowned would have survived if they had worn life jackets. Alcohol was 'involved' in 31% of all the deaths, and said to be the cause of 14%. However, the definition of 'involved' and 'cause' was not provided in the relevant report. Capsizing and falls overboard accounted for 418 (60%) of the 701 deaths, and about 90% of these 418 people drowned. The boat was stationary or drifting in 24% of all deaths. Unfortunately, there was no separate identification of boat operators and passengers (United States Coast Guard 2001).

The Canadian Red Cross study of all drowning deaths in Canada in 1999 reported that boating drownings accounted for 45% of all drownings during recreational activity, and recreational boating accounted for the vast majority of all boating drownings. The study found that 47% of drowning victims associated with recreational boating for which valid blood alcohol levels were available had non-zero BAC, and 30% had BAC greater than 0.08g/100ml. Only eight per cent of the boating-related deaths were not due to drowning, and only one of these persons had a BAC more than 0.08g/100ml (Canadian Red Cross Society 2000).

A case-referent study of all recreational boating deaths occurring in Maryland and North Carolina in the US from 1990– 1998 inclusive identified cases from official state boating fatality records and medical examiner files in the two States. Only deaths that occurred during the 'boating season' (April to October) were included. Some deaths that occurred between 2100 hours and 0700 hours were excluded, as were deaths associated with the use of small crafts such as sailboats, rafts and jet skis, and persons less than 18 years of age. Alcohol measurements in cases were adjusted for time between death and when the sample was taken. The study found that 55% of cases had a non-zero BAC, 27% had a BAC of at least 0.10g/100ml, and 18% had a BAC of 0.15g/100ml or more (Smith, Keyl et al. 2001).

A Louisiana study of all drowning deaths in 1998 provided information on drowning deaths related to boating activities (probably primarily recreational), with blood alcohol measurements based on specimens taken at autopsy. Thirteen of the 34 persons (38%) more than 12 years of age had blood alcohol levels greater than zero (Centers for Disease Control and Prevention 2001).

The Danish study of all 'accidental' drownings in Denmark mentioned earlier found that 14% of all drowning deaths associated with boating were associated with alcohol, including 22% of all leisure boating deaths not including fishing, in-shore shooting and yachting (Steensberg 1998).

An Ohio study of all fatal recreational boating incidents from 1983–1986 was based on official records, for which investigators made a 'judgement about alcohol use', with little information from formal toxicology tests. Eighty per cent of the 124 deaths were due to drowning. Alcohol was said to have 'contributed' to between 7% and 21% of deaths, and to have been the 'contributing cause' in at least 7%. However, the blood alcohol information appears to have been in relation to the boat operators rather than to the deceased persons. Also, the information on alcohol use was neither detailed nor comprehensive, and was not based on formal toxicology testing (Molberg, Hopkins et al. 1993).

The study described earlier of all drowning deaths in a Californian county also provided information on drowning deaths related to boating. Of the 14 persons who drowned in relation to recreational boating, 50% had BAC more than zero, 35% had BAC over 0.05g/100ml, and 28% had BAC more than 0.10 g/100ml (Wintemute, Kraus et al. 1988).

The study described earlier of all drowning deaths in Baltimore for whom valid blood alcohol measurements were available found that 57% of the boating deaths had BAC more than zero, and 43% had BAC greater than 0.15g/100ml (Dietz and Baker 1974).

The early analysis of the Australian drowning study based in Geelong reported that two of the three persons who had drowned in boating incidents and for whom alcohol measurements were available had BAC greater than zero (both greater than 0.15g/100ml) (Plueckhahn 1972).

Finally, a Finnish study of all 'fatal leisure water transport accidents' is described briefly as part of a paper about a study of all 'water transport accidents' in Finland. Ninety-four per cent of the subjects drowned. The alcohol values appear to have been based on blood tests, but not to necessarily relate to the victim, apparently sometimes being from the operator of a boat from which a passenger was killed. No detail is provided on inclusion or exclusion criteria. The paper reports very high proportions of persons with high blood alcohol values—59% of operators and 65% of passengers with BAC greater than or equal to 0.15g/100ml, and 67% of operators and 76% of passengers with BAC greater than or equal to 0.10g/100ml (Lunetta, Penttila et al. 1998).

Recreational diving and spinal cord injury

Alcohol has been shown to significantly impair the ability of divers to perform shallow-water dives in controlled conditions (Perrine, Mundt et al. 1994). Many studies have implicated alcohol as contributing to the occurrence of spinal cord injuries arising from recreational diving, although the extent of involvement of alcohol is not always documented, and there are few measures of the extent of any increased risk arising from alcohol use. The main findings have been summarised by Blanksby and co-workers, who noted alcohol as having contributed to between 15% and 44% of diving-related spinal injuries (Blanksby, Wearne et al. 1997) (although it is probably more correct to say that alcohol had been used in the lead-up, rather than that it clearly contributed to the occurrence of these percentages of diving-related spinal injuries). Some of the more important of these studies are reviewed briefly here.

A United States' study of non-fatal cervical spinal cord injuries occurring in swimming pools found that 49% of injured persons reported 'alcohol involvement' (which appeared to mean alcohol use by the injured person) (DeVivo and Sekar 1997).

Another United States' study of persons injured as a result of recreational diving and requiring hospitalisation, 71% of whom sustained major cervical spine injury, reported that 74% of persons had non-zero blood alcohol levels, and 38% had levels above 0.10g/100ml (Kluger, Jarosz et al. 1994).

A study of all recreational diving injuries of the cervical spine in the mid-west of the United States found that 'alcohol use' was recorded for 44% of patients, and that over half of these had a blood alcohol level of 0.10g/100ml or more (Bailes, Herman et al. 1990).

Table 5.2: Alcohol involvement in recreational aquatic activities—summary of results from main studies

Country	Population	Swim	
United States 2000	All 701 recreational boating fatalities		
Canada 1999	All drowning deaths – 20% in boating collisions	 >0 >0.08	n = 40 63% 53%
United States (Louisiana) 1998	All drownings		
United States (Maryland and North Carolina 1990 – 1998	All recreational boating fatalities of persons 18 years of age or older occurring from April to October inclusive and whose bodies were found with one week of death	>0.05 >0.10 >0.15	36% 27% 11%
Denmark 1989 – 1993	All 'accidental' drowning deaths	n = 38	'under the influence' 32%
Australia (Queenlsand) 1973 – 1992	All resuscitations on a beach, with 89% due to immersion	n = 171 >0	 21%
United States (Ohio) 1983 – 1986	All recreational boating incidents (80% due to drowning)	'Mentioned' 'Cause'	21% 7%
United States (California) 1974 – 1985	All drownings	n = 40 >0 >0.05 >0.10	 63% 55% 40%
United States (North Carolina) 1980 – 1984	All unintentional drownings	n = ? >0.10	 >20%
South Africa (Cape Town) 1980 – 1983	All drownings	n = 87	>0
Australia (Geelong) 1959 – 1983	135 persons 15 years or older who drowned 'accidentally' with valid blood alcohol levels	n = 43 >0 >=0.08 >=0.15	 37% 16% 16%
United States (Maryland) 1968 – 1972	All persons 15 years or older who drowned 'accidentally' and with valid blood alcohol levels	n = 14 >0 >0.10 >0.15	 79% 64% 50%
Australia (Geelong) 1967 – 1971	23 persons 15 years or older who drowned with valid blood alcohol levels	n = 14 >0 >=0.8 >=0.15	 43% 36% 36%

Boat		Alcohol determination criteria	Reference
n = 701 'Involved' 'Cause'	 31% 14%	No details provided	(United States Coast Guard 2001)
N = 122 >0 >0.08	 44% 32%	'Blood testing'—no more details	(Canadian Red Cross Society 2000)
n = 34 >0	 38%	Alcohol (and/or drugs) present in autopsy sample	(Centers for Disease Control and Prevention 2001)
N = 221 >0	 55%	Blood alcohol levels adjusted for time since death	(Smith, Keyl et al. 2001)
n = 94	'under the influence' 14%	Information on alcohol involvement from the death certificate summary	(Steensberg 1998)
		Judged by smell of alcohol on the victim's breath	(Fenner, Harrison et al. 1995)
n = 124		Judgement about alcohol use by investigators – minimal toxicological testing	(Molberg, Hopkins et al. 1993)
n = 14 >0 >0.05 >0.10	 50% 35% 28%	Death within 6 hours; Blood taken with 24 hours of death	(Wintemute, Kraus et al. 1988)
n = ? >0.10	 >20%	'Blood testing'—no more details	(Patetta and Biddinger 1988)
55%		No information	(Davis and Smith 1985)
		Blood alcohol values for the time of death	(Plueckhahn 1984)
n = 7 >0 >0.10 >0.15	 57% 43% 43%	'Blood tests; body submerged less than 12 hours	(Dietz and Baker 1974)
n = 3 >0 >0.08 >0.15	 67% 67% 67%	Blood alcohol values for the time of death	(Plueckhahn 1972)

A small study of persons hospitalised because of spinal injuries arising from water recreation in natural bodies of water, mostly after diving into shallow water, found that six of the 10 persons with information on alcohol use had used alcohol immediately before engaging in the activity that resulted in the injury (Branche, Sniezek et al. 1991).

A study of spinal cord injuries in Denmark found that at least 24% of the persons injured in recreational diving incidents had consumed alcohol immediately before the incident (Biering-Sorensen, Pedersen et al. 1990).

A South African study of recreational cervical spine injuries reported that ‘a high percentage occurred under the influence of alcohol’ (Scher 1981), while a similar South African study published in the same year reported alcohol as a ‘contributing factor’ in 48% of the recreational divers presenting with cervical spine injuries at one hospital, but about 20% at another hospital (Mennen 1981).

A United States study of cervical spine injuries sustained during water-sports found that alcohol ‘contributed’ to a minimum of 16% of the incidents, although the judgement of contribution appears to be based only on the injured person admitting to having drunk alcohol immediately prior to the incident. Many of the subjects did not provide information on alcohol use, so the 16% is probably an underestimate of the percentage of persons who had been drinking, but not necessarily of the proportion of incidents to which alcohol use really did contribute (Good and Nickel 1980).

Table 5.3: Alcohol involvement in recreational diving injuries and spinal cord injuries—summary of results from main studies

Country	Population
United States 1973–?1996	Spinal cord injuries resulting from diving injuries sustained in swimming pools
United States (Pennsylvania) 1987–1991	All recreational diving injuries (71% with cervical spine injuries)
United States (Wisconsin) 1988	Persons hospitalised because of spinal injuries arising from water recreation in natural bodies of water
United States (mid-west) 1975–1986	All recreational diving injuries of the cervical spine
Denmark 1975–1984	Spinal cord injuries from shallow water diving requiring specialist treatment
South Africa (Cape Town) 1964–1980	Spinal injuries from diving presenting to a spinal unit
South Africa (Pretoria) 1969–1979	Spinal injuries from diving presenting to a spinal unit
United States (California) 1965–1976	Cervical spine injuries sustained during water-sports

In addition, people sustaining spinal cord injuries have been found to be more likely to have consumed alcohol immediately prior to the incident than uninjured persons (Branche, Sniezek et al. 1991). Young males and use of alcohol are said to be the two most common characteristics of persons sustaining cervical spinal cord injuries arising from recreational diving (Mennen 1981; Herman and Sonntag 1991).

Measures of risk due to alcohol

There are very few direct measures of risk of serious or fatal injury related to aquatic recreational activities available. Those that are available nearly all cover only drowning. The main available estimates are described here and summarised in Table 5.4.

The best available information comes from the previously mentioned population-based case-referent study of drinking and recreational boating fatalities by Smith and co-workers. This study appears to have included all fatalities, but these are likely to have been predominantly drowning deaths. The study found that alcohol use by the deceased person increased the risk of fatal injury associated with boating. This increased risk was evident at all measurable levels of alcohol from 0.010 g/100ml, and increased with increasing blood alcohol level. The estimated relative risk (RR) was 1.3 (5% CI: 1.2 – 1.4) at 0.010 g/100ml, increasing to 3.7 (2.8 – 4.7) at 0.05 g/100ml, 10.6 (6.9 – 15.7) at 0.10g/100ml and to 52 (95% CI: 26 – 106) at 0.25 g/100ml. The relative risks were similar if fatalities (and the relevant controls) of people who were voluntarily swimming from a boat were excluded, and were similar for boat operators and boat

Alcohol contribution		Alcohol determination criteria	Reference
n= 196 'Involved'	 49%	'Self-reported alcohol involvement'	(DeVivo and Sekar 1997)
n = 58 >0 >0.10	 73% 38%	'Blood alcohol levels'—no more details	(Kluger, Jarosz et al. 1994)
n = 10 'Use'	 60%	Documented or reported alcohol use– no more details	(Branche, Sniezek et al. 1991)
n = 220 'Use' >0.10	 44% at least 23%	Documented alcohol use and 'blood alcohol levels' – no more details	(Bailes, Herman et al. 1990)
n = 34 >0	 24%	'Knowledge of alcohol intake beforehand'	(Biering-Sorensen, Pedersen et al. 1990)
n = 42 'Contributing factor'	 20%	Probably clinical notes and self-report	(Mennen 1981)
n = 23 'Contributing factor'	 48%	Probably clinical notes and self-report	(Mennen 1981)
n = 152 'Contributing factor'	 16%	Self-report	(Good and Nickel 1980)

Table 5.4: Published estimates of risk or relative risk of fatal injury in relation to recreational aquatic activities

Population	Risk measure
All accidental 'recreational boating deaths' occurring in Maryland and North Carolina in the US from 1990–1998, inclusive	Relative risk (RR) of fatal injury in relation to recreational boating
Boating fatalities in California(includes non-recreational activities)	RR of drowning
Drowning deaths (includes non-recreational activities)	RR of drowning
Recreational boating deaths in Ohio	Proportion related to alcohol
All recreational boating deaths in the US	Proportion related to alcohol
All spinal injuries requiring hospitalisation in Wisconsin	Odds ratio (OR) of spinal injury requiring hospitalisation

1. 95% confidence interval for all studies except that by Branche et al. (1991), for which it is a 90% confidence interval.

passengers. The study was well conducted, with careful selection of appropriate controls, and appropriate adjustment of potential confounders or sources of bias such as missing or misleading alcohol values, age, race, sex, occupant status, boat type, location, time of day and weekday/ weekend. Alcohol measurements in cases were adjusted for time between death and when the sample was taken, and alcohol measurements in control subjects were obtained from breath samples (Smith, Keyl et al. 2001).

The only other comparable study was a small study of boating fatalities in California, which found an odds ratio 2.9 for any drinking, and 10.6 for blood alcohol levels above 0.10 g/100ml. Although this study had a small sample size, and incomplete control of possible confounding factors, the odds ratio for alcohol levels above 0.10 g/100ml was very similar to that found in the previous study by Smith and co-workers ((Mengert, Sussman et al. 1992), cited in (Smith, Keyl et al. 2001) and (Howland, Mangione et al. 1996)).

The relative risk of drowning was estimated, by means of a case referent study, to be 31.8 (with a 95% confidence interval of 5.8 to 176) for persons with a blood alcohol level of 0.10 g/ 100ml or more, and 4.6 (1.6 – 13.1) for persons with a non-zero blood alcohol less than 0.10 g/ 100ml (Smith and Houser 1994).

These relative risks were used, in a study of the role of alcohol and medical care in trends in unintentional drowning, to derive percentages of drownings attributable to alcohol (Cummings and Quan 1999). Cummings and Quan attributed 97% of drowning cases at the higher blood alcohol levels to alcohol, and 78% of cases at the lower blood alcohol levels.

Other direct measurements of the contribution of alcohol to recreational aquatic activity serious injuries and deaths have been mentioned above. Alcohol was said to have 'contributed' to between 7% and 21% of recreational boating deaths in Ohio, and to have been the 'contributing cause' in at least 7% (Molberg, Hopkins et al. 1993). Alcohol was 'involved' in 31% of all boat related deaths, and said to be the cause of 14% (United States Coast Guard 2001).

Level	Risk	95% CI	Reference
0.01g/100ml	1.3	1.2 – 1.4	(Smith, Keyl et al. 2001)
0.05g/100ml	3.7	2.8 – 4.7	
0.10g/100ml	10.4	6.9 – 15.7	
0.25g/100ml	52.4	25.9 – 106.1	
more than zero	2.9		(Mengert, Sussman et al. 1992)
0.10g/100ml or greater	10.6		
> zero alcohol	4.6	1.6 – 13.1	(Smith and Houser 1994)
> 0.10g/100ml	31.8	5.8 – 176	
alcohol 'contributed'	7% – 21%		(Molberg, Hopkins et al. 1993)
alcohol 'caused'	7%		
alcohol 'involved'	31%		(United States Coast Guard 2001)
alcohol 'caused'	14%		
'use of alcohol'	4.0	1.1 – 15.0	(Branche, Sniezek et al. 1991)

The only study suggesting a value for the increased risk from alcohol use of injury in recreational diving was a case-referent study by Branche and co-workers. This was a small study of persons hospitalised because of spinal and/or spinal cord injury arising from water recreation in natural bodies of water, mostly after diving into shallow water. There were only 11 cases, and some of these had missing data. Controls were chosen through random digit dialling and were persons who had used a natural body of water last time they had engaged in water recreation. Six of ten cases had consumed alcohol immediately prior to engaging in the water recreational activity (one case had missing information), giving a crude odds ratio of 4.0 (90% CI 1.1 to 15.0) (Branche, Sniezek et al. 1991).

Trends in the role of alcohol

Cummings and Quan applied the attributable percentages they derived to cases identified in coroners' records with non-zero blood alcohol levels. The study found that there was an 81% decline in drowning due to alcohol over the 20 years covered by the study, that 51% of prevented drowning deaths were due to the decrease in alcohol-associated drowning, and the percentage of all drowning due to alcohol fell from 50% to 22% over the 20 years (Cummings and Quan 1999).

The reason for the decline is not known, and it has been suggested that at least part of it may be due to less people being exposed to aquatic recreation, or a greater propensity of people involved in such recreation to engage in the activities in more supervised conditions, situations where alcohol may be banned or used less commonly or in smaller amounts at these more formal venues (Smith and Howland 1999). This could occur, for example, if a greater proportion of swimming occurs at patrolled beaches or in patrolled swimming pools, rather than in open water or inland water. Therefore, it might not be any safer to be engaged in the same aquatic recreational activities that had been undertaken in the past, and the use of alcohol in these activities may not have changed. Instead, the decline in alcohol involvement in drowning might simply be secondary to the change in the type of activities being undertaken, rather than a change in the use or effect of alcohol in particular aquatic activities. However, it appears likely that the majority of the reported change does result from decreased use of alcohol during recreational aquatic activity.

Prevention strategies

Many strategies have been suggested for decreasing the risk of alcohol-related injury during aquatic activities. These are contained in many of the references already cited, and were reviewed recently as part of a general review of countermeasures to reduce drowning and spinal injury from diving into shallow water (Nixon, Pearn et al. 1995). However, few of these have been the subject of rigorous scientific evaluation, and drowning has been called the 'final frontier' of injury prevention (Pless 1997).

Suggested strategies include:

- public service announcements by federal and state government agencies and community-based organisations warning about the dangers of alcohol use in association with water recreation, and tailoring such messages to swimming, boating and/or fishing (Dietz and Baker 1974; Howland and Hingson 1988; Centers for Disease Control and Prevention 1993; Lunetta, Penttila et al. 1998);
- eliminating or modifying advertisements that encourage the use of alcohol during boating activities (Dietz and Baker 1974; Howland and Hingson 1988; Centers for Disease Control and Prevention 1993);
- restricting the sale of alcoholic beverages at aquatic facilities (Howland and Hingson 1988; Centers for Disease Control and Prevention 1993; Fenner 2000)
- passage and enforcement of federal and state legislation restricting alcohol consumption during water-recreation activities (Howland and Hingson 1988; Centers for Disease Control and Prevention 1993; Molberg, Hopkins et al. 1993; Canadian Red Cross Society 2000);
- introduction of stiffer penalties for operating recreational boats under the influence of alcohol (Centers for Disease Control and Prevention 1987);
- making server liability apply to drowning (Wintemute, Kraus et al. 1987);
- limiting the consumption of alcohol by anyone engaged in any form of activity related to water (Adams 1966; Centers for Disease Control and Prevention 1986; Gulaid and Sattin 1988; Bross and Clark 1995; Fenner 2000; Centers for Disease Control and Prevention 2001);
- public education on the risks of drowning if alcohol is consumed while involved in aquatic activities (Plueckhahn 1972; Pearn 1984; Plueckhahn 1984; Centers for Disease Control and Prevention 1986; Wintemute, Kraus et al. 1987; Centers for Disease Control and Prevention 1990; Scher 1992; Howland, Smith et al. 1993; Fenner, Harrison et al. 1995; Howland, Mangione et al. 1996; Lunetta, Penttila et al. 1998; Steensberg 1998; Logan, Sacks et al. 1999; Mackie 1999; Canadian Red Cross Society 2000; Ciraulo, Smith et al. 2000; Bell, Amoroso et al. 2001);

- public education aimed at changing public acceptance of drinking while involved in aquatic activities (Howland, Mangione et al. 1990; Chochinov 1998);
- public education of the potential benefits of alcohol control policies (Girasek, Gielen et al. 2002);
- including information on the risks of alcohol use in all training for boaters (Molberg, Hopkins et al. 1993; Glover, Lane et al. 1995; Bell, Howland et al. 2000);
- focussing on all boat occupants, not just the operators (Howland, Smith et al. 1993; Howland, Mangione et al. 1996; Lunetta, Penttila et al. 1998; Logan, Sacks et al. 1999; Centers for Disease Control and Prevention 2001; Smith, Keyl et al. 2001);
- targeting adult males (Lunetta, Penttila et al. 1998; Logan, Sacks et al. 1999; Canadian Red Cross Society 2000);
- addressing the hazard of combining alcohol with water recreation involving diving (Branche, Sniezek et al. 1991; Perrine, Mundt et al. 1994);
- public education on the risks of sustaining severe injury if alcohol is consumed while involved in recreational diving (Scher 1981; Alexander 1990; Bailes, Herman et al. 1990; Scher 1992; Perrine, Mundt et al. 1994);
- using a standardised sobriety test (McKnight, Lange et al. 1999; Canadian Red Cross Society 2000);

In addition, a number of areas for further research or action have been identified. These include:

- developing a better understanding about the epidemiology of boating and/or non-boating, alcohol-related drowning incidents, including better measures of the association between alcohol and drowning (Wintemute, Kraus et al. 1988; Centers for Disease Control and Prevention 1990; Howland, Mangione et al. 1990; Cummings and Quan 1999);
- obtaining more information on drownings involving particular racial/ethnic groups and women (Bell, Amoroso et al. 2001);
- obtaining information on the possible role of alcohol intake in persons supervising children under six years of age who drown (Davis and Smith 1985);
- obtaining more information on drownings through linkage of health, administrative and risk data sources (Bell, Amoroso et al. 2001);
- determining the effectiveness and acceptability of random sobriety checks for boat operators (Logan, Sacks et al. 1999);
- determining an appropriate permissible BAC or the need for a ‘zero tolerance’ approach regarding alcohol use and boating (Logan, Sacks et al. 1999);
- measuring the impact of laws already in place prohibiting boating whilst intoxicated (Wintemute, Kraus et al. 1988);
- examining the feasibility of controls to limit alcohol consumption by swimmers, especially those aged between 25 and 40 years, and males between 20 and 40 years (Canadian Red Cross Society 2000);

- developing (national) guidelines for the best way to obtain and record information on blood alcohol level in drowning deaths (Warner, Smith et al. 2000); and
- ensuring that Coroners determine the blood alcohol level for all persons 10 years or older who drown (Warner, Smith et al. 2000).

These initiatives can be combined into a small number of groups, such as initiatives to:

- encourage the decreased use of alcohol;
- impose penalties on persons who do have increased blood alcohol levels;
- focus on particular high-risk groups;
- obtain a better understanding of the risks of increased alcohol use and the benefits of various prevention programs.

In terms of encouraging or enforcing decreased alcohol intake in relation to recreational aquatic activity, alcohol has been presumed, almost on an a prior basis, to be a bad thing to combine with recreational aquatic activity. Therefore, activities designed to decrease alcohol consumption in relation to recreational water activity are generally accepted as being appropriate preventive activities. Anecdotal evidence and cases series studies strongly support the presumption that alcohol use is a problem, but it is really only the case-referent study by Smith and co-workers (Smith, Keyl et al. 2001) of fatalities related to recreational boating that provides robust evidence of the extent of increased risk associated with various levels of blood alcohol. However, as mentioned previously, there is very little evidence regarding the effectiveness of any of the prevention initiatives proposed or already in place.

In one of the few trials of prevention approaches, printed information on water safety were given to parents of children attending an emergency department at a paediatric tertiary referral hospital in the United States. The information provided had simple instructions regarding use of life vests, swimming in ‘lifeguarded’ areas, and not using alcohol when swimming or boating. When surveyed one to two weeks after receiving the information, all parents recalled receiving instructions of some sort. In terms of the contents of the instructions, half of the respondents recalled that instructions were regarding water safety . Of these 50%, the instructions were reported to be about life vests (41%), drowning (25%) and swimming (13%). There was no mention in the paper of specific recall regarding alcohol use. Eighty eight per cent of respondents reported that the prevention information was very useful or useful, and the authors concluded that emergency departments could be an appropriate setting for the dissemination of injury prevention information to parents. The study did not investigate whether receiving the information resulted in any change in behaviour in the targeted settings (Quan, Bennett et al. 2001).

In the study by Cummings and Quan described previously, the findings were said to be consistent with the hypothesis that decreased use of alcohol while in or close to water had contributed to the decline in drowning cases. However, the results were also consistent with other causes, and the authors were unaware of any definitive evidence of such decreased alcohol use (Cummings and Quan 1999).

Minimum drinking age laws do not appear to be an important policy initiative for preventing drowning in adolescents and young adults, based on a study of the number of drowning fatalities and the state minimum drinking age laws in the United States, although the authors did not rule out a small effect of the laws (Howland, Birckmayer et al. 1998).

In terms of focussing on apparent high-risk groups Chochinov, in a review of boating fatalities in Canada, argues that alcohol is an important contributor to boating-related drowning, and that it is therefore important that the use of alcohol in association with the operation of a boat be seen as socially irresponsible in the same way as drinking and driving is viewed (Chochinov 1998). However, the focus on boat operators ('designated operators') in campaigns to decrease alcohol use in relation to boating activity has been criticised, because drinking passengers may be at risk regardless of the sobriety or otherwise of the boat operator as a result of the effect of alcohol on balance, judgement, swimming ability and response to cold (Howland, Smith et al. 1993; Howland, Mangione et al. 1996; Smith, Keyl et al. 2001). The authors also argue to decrease the focus on moving boats, since many boating fatalities occur when the boat is stationary or drifting – 24% in the United States in 2000 (United States Coast Guard 2001).

The Australian National Alcohol Strategy actions and outputs are consistent with all these suggested activities related to prevention. The actions focus on:

- increasing community awareness, specially in young people, through promotional material, targeted campaigns and inclusion of alcohol messages in water safety campaigns;
- using legislation and education to reduce boating-related incidents associated with alcohol; and
- increasing knowledge and understanding of the factors associated involved in alcohol-related aquatic incidents through improving data collections and commissioning reports such as the current one (Department of Health and Aged Care 2001).

6 Summary and conclusions

Attributable fractions and mortality data

Assessment of drowning attributable to alcohol in Australia depends on the completeness and reliability of the identification of drowning deaths and on the availability and validity of attributable fractions.

Death registration is generally considered to be nearly complete in Australia, and drowning is usually a well-defined cause of death. Hence, estimates of drowning mortality in Australia are probably fairly complete and reliable. When a recently deceased body is available for post mortem examination, ascertainment of this mechanism of death should be reliable. Some bodies are lost at sea or in similar circumstances. Drowning may be arrived at as the presumptive or probable mechanism of death in such cases. Presumably some deaths by drowning are not identified as such, either because too little is known about the mechanism of a known death to come to a conclusion, or because a death remains unknown. However, these are not likely to amount to more than a small number of deaths.

The availability and reliability of attributable fractions is the limiting factor for this approach to estimating and perhaps monitoring the role of alcohol as a cause of drowning in Australia.

Application of the age-specific fractions from English et al. (1995) produced an estimate of an average of about 74 'accidental drowning' deaths per year attributable to 'hazardous or harmful' levels of alcohol consumption in the period 1997–2000. If the same attributable fractions are applicable to drowning deaths more generally, then the total number of drowning deaths in Australia due to alcohol is about 130.

A flag for 'alcohol-related' deaths is added to the mortality data file by the ABS. The scope, validity and reliability of this item have been uncertain.

NCIS as an information source

The analysis in Chapter 3 is one of the first uses of the National Coroners Information System (NCIS) as an information source on a significant public health issue. The NCIS appears to already provide very useful, and in some places comprehensive, information, but still has significant shortcomings in terms of the completeness and detail of information on many cases. The availability and quality of data also varies considerably between jurisdictions.

On the basis of this analysis of NCIS data, drowning is a significant cause of death in Australia. Alcohol appears to contribute to about 21% of drowning deaths, and perhaps 30% of drowning deaths related to recreational aquatic activity. Nearly half of all drowning cases occur in relation to recreational aquatic activity, and there are also a small number of non-drowning deaths related to recreational aquatic activity.

ED surveillance

National surveillance of alcohol relatedness among immersion or near-drowning cases presenting to Australian EDs is not feasible at present.

There is currently no national ED data collection system, although there are two State-based ED data collection systems, QISU and VISAR. Neither VISAR not QISU includes data items designed to identify alcohol relatedness.

'Alcohol relatedness' is not a well-defined concept, particularly at the level of individual cases. Alcohol levels of persons attending EDs could, in principle, be measured. This has been required by legislation for certain types of case (eg. motorists) and has been done successfully in some special studies of relatively small numbers of injury cases. However, barriers to ascertainment of alcohol levels, or its presence above a threshold level, among ED cases generally and at a national level are likely to be high.

EDs are a suitable setting for collecting data for injury case characterisation. They are not a good principal setting for data collection for population-based measuring and monitoring of immersion and near-drowning. Only some fatal cases can be identified via EDs, because many bodies are recovered too late for any hope of resuscitation, and other deaths occur after admission. While serious non-fatal cases might be identified through EDs, such cases are also likely to be admitted to hospital and, hence, to be recorded in inpatient statistics (Steenkamp 2002). Some cases of immersion or near-drowning without serious consequences attend an ED, but (depending on choice of definitions, which are not well-established) these are likely to be a small and unrepresentative sample of all such cases.

Literature review

Evidence from North America suggests that alcohol is widely used in association with recreational aquatic activity, although there is no information regarding the extent of use in Australia. A priori and anecdotal evidence suggests alcohol is an important risk factor for death and serious injury arising from recreational aquatic activity. Specific studies confirm this, but the extent of increased risk associated with alcohol use, and the attributable risk due to alcohol use, is not well characterised.

It appears that, as in most deaths associated with recreational aquatic activity, drowning is the most common water-related injury associated with alcohol. Alcohol is detected in the blood of about 30% to 50% of fatally injured persons involved in recreational aquatic activity. The few relevant studies on degree of increased risk suggest persons with a blood alcohol level of 0.10g/100ml have about 11 times the risk of death associated with recreational boating compared with persons who have not been drinking, but that even small amounts of alcohol can increase this risk. The population attributable risk seems to be in the range of about 10% to 30%.

The increased risk due to alcohol use of cervical spine injury associated with diving into water is also not well characterised.

There is very little information on the role of alcohol in recreational aquatic activity, and serious and fatal injury associated with recreational aquatic activity, in Australia.

Many prevention activities have been suggested in the literature, as well as areas for further work. The main areas from an Australian perspective where further work is needed appear to be:

- determining the extent of alcohol use in Australia in relation to recreational aquatic activity;
- obtaining information on the knowledge, attitudes and behaviours of Australians in relation to alcohol use and aquatic activity;
- undertaking analytic studies to determine the relationship between alcohol levels and the extent of increase in risk of serious or fatal injury in association with recreational aquatic activity in Australia; and

- evaluation of current and proposed interventions to reduce the contribution of alcohol to serious and fatal recreational aquatic activity.

Overall conclusions and recommendations

Routine Australian mortality data provide a good basis for measuring and monitoring rates of drowning and some relevant characteristics of death by this means.

This information source alone is not sufficient for assessing the contribution of alcohol to drowning in Australia, or other adverse consequences of aquatic activities. Published attributable fractions provide a simple approach to estimating the contribution of alcohol to drowning, and we have reported some estimates of this type. However, these estimates are not very reliable.

Ideally, an assessment would be based on the following information:

i. Reliable identification of deaths by drowning in Australia.

ii. Reliable information on alcohol intoxication by people who have died by drowning in Australia.

iii. Evidence of the relationship between alcohol use and risk of drowning based on analytic studies. The studies should have characteristics which make it likely that their findings are applicable (i.e. generalisable) to drowning in Australia.

iv. Reliable and recent information on patterns of alcohol use among people exposed to risk of drowning in Australia.

Assessment of the contribution of alcohol to 'near-misses' for death or serious harm is complicated by the lack of information on relevant events. This is particularly so for near drowning, which does not lend itself to measurement. Data collection at emergency departments does not provide a satisfactory basis for quantitative monitoring of 'near-miss' drowning and its relationship with alcohol. An uncertain, and probably small and variable, proportion of cases meeting a broad definition (e.g. swimmers assisted by lifesavers) present to this setting. Restriction of attention to cases whose medical condition makes attendance at an emergency department likely (e.g. immersion resulting in loss of consciousness) would, in principle, improve the feasibility of valid monitoring. The main existing emergency department data systems, which collect information about injuries including drowning, cover a small proportion of all emergency departments and do not obtain information on alcohol.

More meaningful information about 'near-miss' cases generally would probably be better obtained in other and more direct ways (e.g. life saving records; case-control studies of participants in aquatic activities).

An important but relatively small number of cases occur in which potentially fatal events are survived with residual harm (notably hypoxic brain damage following immersion). Hospital separations data can provide some information, but more complete and reliable information on such cases could be obtained by means of a register. Emergency department collections, where present, could provide some useful case information. However, condition on presentation may not provide a good guide to case outcome, and other sources would be needed (i.e. acute hospital and rehabilitation service records).

In addition, prevention of alcohol-related drowning effectively requires an understanding of the setting and circumstances of drowning, with and without involvement of alcohol. This implies a requirement for a fifth type of information:

v. Detailed information characterising people, places and events associated with drowning in ways likely to provide insights relevant to prevention.

Information on total drowning mortality provides an upper limit to possible alcohol-related drowning mortality.

Information on alcohol levels of people who have drowned enables estimation of the proportion of all drowning attributable to alcohol. Cases with BAC of zero soon after death probably were not due to alcohol (though some might be due to alcohol consumption by another person). A reasonable argument can be made that drowning cases with high BAC levels are likely to be attributable to this factor. However, the presence of alcohol is not necessarily causally related to an individual death by drowning.

Evidence on the relationship between alcohol level and risk of drowning helps to enable interpretation of information on BAC levels at death. In combination with information on alcohol use among people exposed to risk of drowning and the other two types of information already mentioned, risk information enables direct estimation of the proportion of drowning attributable to alcohol.

On the basis of this project, we offer the following conclusions and recommendations concerning the status of information relevant to alcohol and safety during aquatic activities, and the prospects for improving this information.

***Note*:** The scope of this project also included non-drowning deaths in the context of recreational aquatic activities, which are attributable to alcohol. We found a small number of such deaths, but the overwhelming majority of in-scope deaths were by drowning. Accordingly, we have focused on drowning in framing our summary and conclusions.

(i) Reliable identification of deaths by drowning

- Routine Australian mortality data from the ABS provide a good basis for measuring and monitoring rates of drowning and some relevant characteristics of death by this means. Ascertainment based on this source is probably complete, or nearly so. Timeliness is limited (data for a calendar year become available about a year after it ends).

- According to this source, in recent years, there have been about 400 drowning deaths per annum in Australia, about two-thirds of which meet a commonly used definition of ‘accidental drowning’ (i.e. Underlying Cause of Death = ICD-10 codes X65–X74). Rates of drowning mortality have declined.

- The new National Coroners Information System (NCIS) appears to identify about the same number of drowning deaths as the ABS mortality data. A strength of the NCIS is that it provides more extensive and detailed information about most cases. A potential strength is that it might be able to provide sufficiently complete data more quickly than the routine mortality data system. A limitation at the time of this analysis was the lack of access to information on deaths in Queensland.

CONCLUSION:

Current information sources provide adequate information on drowning for this purpose. Timeliness is the attribute most warranting improvement.

RECOMMENDATIONS:

Continue to use ABS mortality data as the basis for monitoring drowning mortality. Supplement this with NCIS because of the additional case information which it provides. Continue to assess NCIS for other benefits, with particular reference to timeliness and to data on Queensland deaths (when available).

(ii) Reliable information on alcohol intoxication by people who have died by drowning in Australia.

- A widely-used Australian assessment of drug-caused mortality and morbidity attributes about one-third of 'accidental drowning' deaths to alcohol, using a criterion of blood alcohol of 0.10 g/100ml or higher (English, Holman et al. 1995). This is derived from a limited evidence base and should not be regarded as precise or current. This has been the best available basis for estimating alcohol-related drowning in Australia to date.
- A 'drug flag' item in the ABS mortality data set indicates cases that have been noted as having some connection with alcohol. The meaning of the flag is hard to interpret precisely because criteria for flagging are not well specified and extend beyond the scope of acute intoxication, and because completeness of ascertainment is uncertain.
- Analysis of data from the new National Coroners Information System indicates that alcohol was a factor in about 21% of drowning deaths in Australia in 2000–01 (18% where blood alcohol was 0.10 g/100ml or higher). The proportion of cases with evidence of alcohol involvement was 30% for drowning while engaged in recreational activities. (Note that deaths in Queensland were not available for analysis.)

CONCLUSION:

Estimation based on published attributable fractions has been the best available basis for estimating alcohol-related drowning mortality in Australia. The NCIS appears to provide a better basis for assessing and monitoring alcohol-relatedness of drowning deaths in Australia than the published attributable fractions. Its value for this purpose will be confirmed when data become available for Queensland. Its value will be enhanced by speedier closure of cases (or release of blood alcohol data prior to closure) and by inclusion in NCIS case records of Underlying Cause of Death codes, as determined by the ABS. Our analysis of initial NCIS data suggests that the fraction of drowning deaths in Australia attributable to alcohol is lower than that proposed by English et al. in all age groups, especially at ages 60 years and older.

The ABS drugs flag item could become more useful for this purpose if the criteria for flagging 'alcohol-relatedness' were specified, and if the flag included a value meaning 'a test for alcohol was done and none was found' (or that the result was below a chosen criterion, such as 0.10 g/100/ml), and a value meaning 'BAC not assessed' or 'no information'.

RECOMMENDATIONS:

- ***Use NCIS data to derive future estimates of relevant alcohol use among people who have drowned in Australia.***
- ***Re-analyse NCIS data periodically (e.g. annually) to monitor presence and levels of alcohol among drowning deaths.***
- ***Advocate liaison between ABS and the operators of the NCIS (i.e. the Monash University National Centre for Coronial Information, MUNCCI) with a view to developing the 'drug flag' so that it becomes interpretable as an indicator of BAC at death.***
- ***Advise the Monash University National Centre for Coronial Information (MUNCCI) of the usefulness of the NCIS data for this project. Also inform MUNCCI of the project officers' recommendation that a mechanism should be developed to enable data corrections made during a project such as this to be applied (after appropriate checking) to the main NCIS data collection.***

(iii) Evidence of the relationship between alcohol use and risk of drowning based on analytic studies.

- We found very few good quality studies in the world literature, and none that were conducted in Australia. Nevertheless, available evidence indicates a strong relationship between blood alcohol and risk of recreational boating fatalities and drowning, with increase in risk detected at low BAC levels and large relative risks (10-fold or more) found at BAC 0.10 g/100ml or higher.
- The existing evidence, argument by analogy with literature on risk due to alcohol in other settings (e.g. driving) and a cautious approach provide a basis for arguing against any use of alcohol during, or in relevant periods before, aquatic activities. However the specific evidence base warrants expansion, particularly to confirm apparent elevation of risk at low BAC levels (i.e. 0.05 g/100ml and lower) and to broaden the range of types of aquatic activity for which evidence on alcohol and risk is available.

CONCLUSION:

Current information provides an adequate basis for concluding that alcohol intoxication increases the risk of drowning during aquatic activities. However, it is not adequate to provide robust information concerning the shape of the relationship (including thresholds), nor about possible variation in the relationship between settings and types of aquatic activities.

RECOMMENDATIONS:

Advocate that one or a small number of analytic studies should be undertaken, preferably in Australia, to provide confirmatory and more specific evidence of the relationship between BAC and risk of drowning (or of adverse consequences of aquatic activities more broadly). Existing studies provide relevant examples (Smith and Houser 1994; Smith, Keyl et al. 2001).

(iv) Reliable and recent information on patterns of alcohol use among people exposed to risk of drowning in Australia.

- Australian data on alcohol use in the context of aquatic activities appears to be absent from published literature. We found a modest but useful amount of information concerning other countries, especially the USA. However, information on alcohol use in other countries is not likely to be a reliable guide to alcohol use by people exposed to risk of drowning, etc in Australia.

CONCLUSION:

Information about the use of alcohol in the context of aquatic activities in Australia is inadequate both for reliable estimation of the proportion of drowning attributable to alcohol, or to provide a basis for information-based policy response (e.g. monitoring effects of programs to discourage drinking before swimming or while boating).

RECOMMENDATIONS:

Undertake or advocate for studies of alcohol use in the context of aquatic activities. The studies should seek information on knowledge and attitudes concerning alcohol use and risks, as well as information about its use.

(v) Detailed information characterising people, places and events associated with drowning in ways likely to provide insights relevant to prevention.

- The NCIS provides accessible and increasingly comprehensive information on many factors related to drowning in Australia (and other deaths due to external causes). This source can be used to examine drowning cases descriptively, as we have done in this report, in ways not previously practicable. Some drowning deaths are the subject of full inquests, and the NCIS provides ready access to the findings reached by coroners after detailed inquiries and investigations. In addition, data from the NCIS could be used as part of analytic investigations into risk factors for drowning, such as alcohol (as recommended above).
- Effective prevention is likely to result from a thorough understanding of aquatic activities, alcohol use, and the way that these interact. Several forms of information can contribute to this understanding. Case-control studies can enable comparison of characteristics of participants in aquatic activities (including their use of alcohol) who did and did not drown (or experience another undesirable outcome). Surveys of participants can improve understanding of patterns of use of alcohol during aquatic activities, and about the knowledge and attitudes of participants to use. Trials can be designed to test and evaluate the effectiveness of interventions designed to reduce alcohol-related harm during aquatic activities.

CONCLUSION:

The NCIS is a rich new source of information, which can be used to characterise as well as to quantify deaths due to external causes, including alcohol-related drowning. It differs in some ways from other sources, and learning how to make the most of its potential requires experience. Special studies can provide a more complete understanding to guide effective reduction of alcohol-related harm during aquatic activities.

RECOMMENDATIONS:

Continue to test and use the NCIS concerning alcohol and water safety, and other issues concerning drugs and alcohol. Advocate for special studies, including one or more case-control studies, and surveys of alcohol use, knowledge and attitudes in the context of aquatic activities.

Australian National Alcohol Strategy

The Australian National Alcohol Strategy actions and outputs are consistent with activities related to prevention suggested in the published literature. The actions call for:

- increasing community awareness, especially in young people, through promotional material, targeted campaigns and inclusion of alcohol messages in water safety campaigns;
- using legislation and education to reduce boating-related incidents associated with alcohol; and
- increasing knowledge and understanding of the factors associated involved in alcohol-related aquatic incidents through improving data collections and commissioning reports such as the current one (Department of Health and Aged Care 2001).

The only area that is not well covered by the Strategy is the need to evaluate programs already in place or to be introduced.

Recommendations presented in this report chiefly expand on the third of these points, and advocate further investigations to:

- determine the extent of alcohol use in Australia in relation to aquatic activities;
- obtain information on the knowledge, attitudes and behaviours of Australians in relation to alcohol use and aquatic activity;
- determine the extent of increased risk of serious and fatal injury in association with aquatic activities in Australia; and
- evaluate current and proposed interventions to reduce the contribution of alcohol to serious and fatal recreational aquatic activity.

7 References

Adams, A. (1966). "The descriptive epidemiology of drowning accidents." Medical Journal of Australia **27**(2): 1257-1261.

Alexander, E. J. (1990). "Don't drink and dive." Surgical Neurology **34**: 159.

Australian Sports Commission (2002). Participation in exercise, recreation and sport 2001. Canberra, Australian Sports Commission.

Bailes, J., J. Herman, et al. (1990). "Diving injuries of cervical spine." Surgical Neurology **34**(3): 155-158.

Bell, N., P. Amoroso, et al. (2001). "Alcohol and other risk factors for drowning among male active duty U.S. army soldiers." Aviation, Space and Environmental Medicine **72**(12): 1086-1095.

Bell, N., J. Howland, et al. (2000). "Boater training, drinking and boating, and other unsafe boating practices." Journal of Drug Education **30**(4): 467-482.

Biering-Sorensen, F., V. Pedersen, et al. (1990). "Epidemiology of spinal cord lesions in Denmark." Paraplegia **28**: 105-118.

Blanksby, B., F. Wearne, et al. (1997). "Aetiology and occurrence of diving injuries. A review of diving safety." Sports Medicine **23**(4): 228-246.

Branche, C., J. Sniezek, et al. (1991). "Water recreation-related spinal injuries: risk factors in natural bodies of water." Accident Analysis and Prevention **23**(1): 13-17.

Britt, H., G. Sayer, et al. (1999). Bettering the evaluation and care of health: a study of general practice activity. Six month interim report, Australian Institute for Health and Welfare and University of Sydney.

Bross, M. and J. Clark (1995). "Near-drowning." American Family Physician **51**(6): 1545-1548.

Cairns, F., T. Koelmeyer, et al. (1984). "Deaths from drowning." New Zealand Medical Journal **97**(749): 65-67.

Canadian Red Cross Society (2000). An analysis of drownings and other water-related injury fatalities in Canada for 1999. Montreal, Canadian Red Cross Society.

Centers for Disease Control and Prevention (1986). "North Carolina drownings, 1980-1984." Morbidity & Mortality Weekly Report **35**: 635-638.

Centers for Disease Control and Prevention (1987). "Recreational boating fatalities - Ohio, 1983-1986." Journal of the American Medical Association **258**(1): 22,24.

Centers for Disease Control and Prevention (1990). "Alcohol use and aquatic activities - Massachusetts, 1988." Morbidity and Mortality Weekly Report **39**(20): 332-334.

Centers for Disease Control and Prevention (1993). "Alcohol use and aquatic activities - United States, 1991." Morbidity and Mortality Weekly Report **42**(35): 675, 681-683.

Centers for Disease Control and Prevention (2001). "Drowning - Louisiana, 1998." Morbidity & Mortality Weekly Report **50**(20): 413-414.

Chikritzhs, T., H. Jonas, et al. (1999). Alcohol-caused deaths and hospitalisations in Australia, 1990-1997. Perth, National Drug Research Institute**:** 4.

Chochinov, A. (1998). "Alcohol "on board", man overboard - boating fatalities in Canada." Canadian Medical Association Journal **159**(3): 250-260.

Ciraulo, D., P. Smith, et al. (2000). "A trauma systems assessment of boating safety: a comparison of commercial and recreational boating practices." The American Surgeon **66**(6): 604-607.

Cripps, R., M. Steenkamp, et al. (2002). Hospital separations due to injury and poisoning, Australia 1998-99. Canberra, Australian Institute of Health and Welfare.

Cummings, P. and L. Quan (1999). "Trends in unintentional drowning: the role of alcohol and medical care." Journal of the American Medical Association **281**(23): 2198-2202.

Davis, S. and L. Smith (1985). "The epidemiology of drowning in Cape Town: 1980-1983." South African Medical Journal **68**(10): 739-742.

Day, L., G. Valuri, et al. (1997). General Practice Injury Surveillance in the Latrobe Valley. Clayton, Monash University Accident Research Centre.

Department of Health and Aged Care (2001). Alcohol in Australia: issues and strategies. Canberra, Department of Health and Aged Care.

Department of Health and Aged Care (2001). National Alcohol Strategy. A plan for action 2001 to 2003-04. Canberra, Department of Health and Aged Care.

Department of Health and Aged Care (2001). National Injury Prevention Action Plan: Priorities for 2001-2003. Implementation Plan. Canberra, Department of Health and Aged Care**:** 36.

DeVivo, M. and P. Sekar (1997). "Prevention of spinal cord injuries that occur in swimming pools." Spinal Cord **35**(8): 509-515.

Dietz, P. and S. Baker (1974). "Drowning. Epidemiology and prevention." American Journal of Public Health **64**(4): 303-312.

Drew, L. (1982). Death and drug use in Australia, 1969 to 1980. Canberra, Australian Government Publishing Service.

English, D., C. Holman, et al. (1995). The quantification of drug caused morbidity and mortality in Australia 1995. Canberra, Commonwealth Department of Human Services and Health.

Fenner, P. (2000). "Drowning awareness. Prevention and treatment." Australian Family Physician **29**(11): 1045-1049.

Fenner, P., S. Harrison, et al. (1995). "Success of surf lifesaving resuscitations in Queensland, 1973-1992." Medical Journal of Australia **163**(11-12): 580-583.

Girasek, D. (2001). "Public beliefs about the preventability of unintentional injury deaths." Accident Analysis and Prevention **33**(4): 455-465.

Girasek, D., A. Gielen, et al. (2002). "Alcohol's contribution to fatal injuries: a report on public perceptions." Annals of Emergency Medicine **39**(6): 622-630.

Glover, E., S. Lane, et al. (1995). "Relationship of alcohol consumption and recreational boating in Beaufort County, North Carolina." Journal of Drug Education **25**(2): 149-157.

Good, R. and V. Nickel (1980). "Cervical spine injuries resulting from water sports." Spine **5**(6): 502-506.

Gooden, B. (1972). "Drowning and the diving reflex in man." Medical Journal of Australia **2**(11): 583-587.

Gooden, B. (1984). "Drowning and alcohol." Medical Journal of Australia **141**: 478.

Gulaid, J. and R. Sattin (1988). "Drownings in the United States, 1978-1984." Morbidity & Mortality Weekly Report **37**(SS-1): 27-33.

Harrison, J., E. Miller, et al. (2001). Information sources for injury prevention among Indigenous Australians. Status and prospects for improvement. Adelaide, Australian Institute of Health and Welfare.

Harrison, J. and M. Steenkamp (2002). Technical review and documentation of current NHPA injury indicators and data sources. Canberra, Australian Institute of Health and Welfare.

Helps, Y., R. Cripps, et al. (2002). Hospital separations du eto injury and poisoning, Australia 1999-00. Canberra, Australian Institute of Health and Welfare.

Herman, J. and V. Sonntag (1991). "Diving accidents. Mechanism of injury and treatment of the patient." Critical Care Nursing Clinics of North America.

Hingson, R. and J. Howland (1993). "Alcohol and non-traffic unintended injuries." Addiction **88**: 877-883.

Holman, C. and B. Armstrong (1990). The quantification of drug caused mortality in Australia 1989. Canberra, Commonwealth Department of Community Services and Health.

Holman, C., B. Armstrong, et al. (1990). The quantification of drug caused mortality in Australia 1988. Canberra, Commonwealth Department of Community Services and Health.

Howland, J., J. Birckmayer, et al. (1998). "Did changes in minimum age drinking laws affect adolescent drowning (1970-90)?" Injury Prevention **4**: 288-291.

Howland, J. and R. Hingson (1988). "Alcohol as a risk factor for drownings: a review of the literature (1950-1985)." Accident Analysis and Prevention **20**(1): 19-25.

Howland, J., R. Hingson, et al. (1996). "Why are most drowning victims men? Sex differences in aquatic skills and behaviours." American Journal of Public Health **86**(1): 93-96.

Howland, J., T. Mangione, et al. (1990). "A pilot survey of aquatic activities and related consumption of alcohol,

with implications for drowning." Public Health Reports **105**(415-419).

Howland, J., T. Mangione, et al. (1996). "Perceptions of risk of drinking and boating among Massachusetts boaters." Public Health Reports **111**: 372-377.

Howland, J., G. Smith, et al. (1993). "Missing the boat on drinking and boating." Journal of the American Medical Association **270**(1): 91-92.

Johnstone, J. (1985). "Alcohol and drowning." Medical Journal of Australia **142**(3): 234-235.

Kluger, Y., D. Jarosz, et al. (1994). "Diving injuries: a preventable catastrophe." Journal of Trauma **36**(3): 349-351.

Last, J. M. (2001). A dictionary of epidemiology. New York, Oxford University Press.

Logan, P., J. Sacks, et al. (1999). "Alcohol-influenced recreational boat operation in the United States, 1994." American Journal of Preventive Medicine **16**(4): 278-282.

Lunetta, P., A. Penttila, et al. (1998). "Water traffic accidents, drowning and alcohol in Finland, 1969-1995." International Journal of Epidemiology **27**(6): 1038-1043.

Mackie, I. (1999). "Patterns of drowning in Australia, 1992-1997." Medical Journal of Australia **171**(11-12): 587-590.

McClure, R. (1994). The Public Health Impact of Minor Injury. National Centre for Epidemiology and Population Health. Canberra, Australian National University**:** 162.

McKnight, A., J. Lange, et al. (1999). "Development of a standardized boating sobriety test." Accident Analysis and Prevention **31**(1-2): 147-152.

McLeod, R., T. Stockwell, et al. (1999). "The relationship between alcohol consumption

patterns and injury." Addiction **94**(11): 1719-1734.

Mengert, P., E. Sussman, et al. (1992). A study of the relationship between the risk of fatality and blood alcohol concentration of recreational boat operators. Washington D.C., U.S. Coast Guard.

Mennen, U. (1981). "A survey of spinal injuries from diving. A study of patients in Pretoria and Cape Town." South African Medical Journal **59**(22): 788-790.

Modell, J. (1981). "Drown versus near-drown: a discussion of definitions." Critical Care Medicine **9**(4): 351-352.

Molberg, P., R. Hopkins, et al. (1993). "Fatal incident risk factors in recreational boating in Ohio." Public Health Reports **108**(3): 340-346.

Nixon, J., J. Pearn, et al. (1995). Review of countermeasures to reduce drowning, near-drowning and spinal injuries from diving into shallow water. Canberra, Commonwealth Department of Human Services and Health.

O'Connor, P. (2000). Spinal cord injury, Australia 1998/99. Australian Injury Prevention Bulletin 22. Adelaide, Research Centre for Injury Studies, Flinders University of South Australia.

O'Connor, P. and R. Trembath (1995). An investigation of missing values of blood alcohol concentration in road crash databases. Adelaide, AIHW National Injury Surveillance Unit**:** 1-59.

Patetta, M. and P. Biddinger (1988). "Characteristics of drowning deaths in North Carolina." Public Health Reports **103**(4): 406-411.

Pearn, J. (1984). "Drowning and alcohol." Medical Journal of Australia **141**(1): 6-7.

Perrine, M., J. Mundt, et al. (1994). "When alcohol and water don't mix: diving under the influence." Journal of the Study of Alcohol **55**(5): 517-524.

Pless, B. (1997). "The challenge of drowning prevention (editorial)." Injury Prevention **3**: 237-238.

Plueckhahn, V. (1972). "The aetiology of 134 deaths due to "drowning" in Geelong during the years 1957 to 1971." Medical Journal of Australia **2**: 1183-1187.

Plueckhahn, V. (1984). "Alcohol and accidental drowning: a 25-year study." Medical Journal of Australia **141**(1): 22-25.

Quan, L., E. Bennett, et al. (2001). "Do parents value drowning prevention information at discharge from the emergency department/." Annals of Emergency Medicine **37**(4): 382-385.

Ridolfo, B. and C. Stevenson (2001). The quantification of drug-caused morbidity and mortality in Australia, 1998. Canberra, Australian Institute of Health and Welfare.

Roche, A. M., K. Watt, et al. (2001). "Injury and Alcohol: A Hospital Emergency Department Study." Drug Alcohol Rev **20**: 155.166.

Royal Life Saving Society of Australia (2001). The national drowning report 2001. Sydney, RLSSA.

Scher, A. (1981). "Diving injuries to the cervical spinal cord." South African Medical Journal **59**: 603-605.

Scher, A. (1992). "Diving injuries of the spinal cord." South African Medical Journal **81**: 291-292.

Smith, G., C. Branas, et al. (1999). "Fatal nontraffic injuries involving alcohol: A meta-analysis." Annals of Emergency Medicine **33**(6): 659-668.

Smith, G. and J. Houser (1994). Risk factors for drowning: a case-control study (abstract). 122nd Annual meeting of the American Public Health Association, Washington, DC, American Public Health Association.

Smith, G. and J. Howland (1999). "Declines in drowning. Exploring the epidemiology of favourable trends (editorial)." Journal of the American Medical Association **281**(23): 2245-2247.

Smith, G., P. Keyl, et al. (2001). "Drinking and recreational boating fatalities: a population-based case-control

study." Journal of the American Medical Association **286**(23): 2974-2980.

Smith, G. S. and J. D. Langley (1998). "Drowning surveillance: how well do E codes identify submersion fatalities." Injury Prevention **4**(2): 135-9.

Sommers, M., J. Dyehouse, et al. (1997). Self-reported alcohol consumption following motor vehicle crashes: a validity study in non-dependent drinkers. 41st Annual Proceedings Association for the Advancement of Automotive Medicine, Orlando, Florida.

Steenkamp, M. (2002). Persisting morbidity among hospitalisations for near drowning, Australia 1997-98. Adelaide, Australian Institute of Health and Welfare**:** 55.

Steenkamp, M., J. Harrison, et al. (2002). Alcohol-related injury and young males. Adelaide, Australian Institute of Health and Welfare**:** 109.

Steensberg, J. (1998). "Epidemiology of accidental drowning in Denmark 1989-1993." Accident Analysis and Prevention **30**(6): 755-762.

United States Coast Guard (2001). Boating statistics - 2000. Washington, DC, US Coast Guard.

Waller, J. (1972). "Nonhighway injury fatalities. I. The roles of alcohol and problem drinking, drugs and medical impairment." Journal of Chronic diseases **25**: 33-45.

Warner, M., G. Smith, et al. (2000). "Drowning and alcohol in New Zealand: what do the coroner's files tell us?" Australian and New Zealand Journal of Public Health **24**(4): 387-390.

Wintemute, G., J. Kraus, et al. (1987). "Drowning in childhood and adolescence: a population-based study." American Journal of Public Health **77**(7): 830-832.

Wintemute, G., J. Kraus, et al. (1988). "The epidemiology of drowning in adulthood: implications for prevention." American Journal of Preventive Medicine **4**(6): 343-348.

Wintemute, G., S. Teret, et al. (1990). "Alcohol and drowning: an analysis of contributing factors and a discussion of criteria for case selection." Accident Analysis and Prevention **22**(3): 291-296.

Appendix

Appendix 8.1: Object codes that may be useful in identifying drowning deaths and deaths associated with alcohol

G WATER CRAFT AND MEANS OF TRANSPORT

Includes watercraft in recreational and transport activities

G09 Merchant ship
G19 Passenger ship
G29 Fishing boat
G33 Jet ski
G35 Motorboat
G36 Hovercraft
G38 Other specified powered watercraft
G39 Unspecified powered watercraft
G49 Sailboat
G59 Canoe or kayak
G69 Inflatable craft (non-powered)
G79 Water skis
G88 Other specified non-powered watercraft
G89 Unspecified non-powered watercraft
G98 Other specified watercraft
G99 Unspecified watercraft

K ANIMAL, PLANT, PERSON

K51 Fish
K52 Shark
K53 Sea snake *Excludes nonvenomous sea snake (K58)*
K54 Marine mammal, e.g. dolphin, whale, etc
K56 Jellyfish
K57 Coral
K58 Other specified marine animal nec *Includes anemone, cucumber, urchin; Excludes marine mammals (K54)*
K59 Unspecified marine animal

L GROUND SURFACE AND CONFORMATIONS

L50 Fishpond/ornamental lake
L51 Dam, lake, water reservoir
L52 River, stream
L53 Swamp, marsh
L54 Beach, seashore, sea and rocks

M WEATHER, NATURAL DISASTERS

M19 Storm

Includes blizzard, cloudburst, hurricane, tidal wave caused by storm, torrential rain; transport vehicle washed off road by storm

Excludes if transport accident follows storm (use E.— or F.—); if storm causes collapse of man-made structure causing earth movement (M69)

M29 Flood

Includes flood arising from remote or direct storm, melting snow of cataclysmic nature. Excludes flood caused by collapse of dam or man-made structure causing earth movement (M69) or caused by storm (M19)

P DRUGS (INCLUDING ALCOHOL AND PHARMACEUTICALS)

P01 Alcohol

Q CHEMICAL SUBSTANCE, NON-PHARMACEUTICAL

Q09 Alcohol nec (e.g. methanol, propanol, isopropanol)

R BUILDING, BUILDING COMPONENT OR FITTING

R02 Bathtub *Includes internal spa bath*

R04 Shower

R13 Swimming pool – above ground

R14 Swimming pool – in ground

R15 External spa bath

Abbreviations

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
BAC	Blood Alcohol Concentration
DHA	Department of Health and Ageing
ED	Emergency department
GP	General practitioner
ICD-9	9th Revision of the International Classification of Diseases
ICD-9-CM	9th Revision of the International Classification of Diseases, Clinic Modification
ICD-10	10th Revision of the International Classification of Diseases
ICD-10-AM	10th Revision of the International Classification of Diseases, Australian Modification
MCoD	Multiple cause of death
MUARC	Monash University Accident Research Centre
MUNCCI	Monash University National Centre for Coronial Information
—	Not applicable
NHDD	National Health Data Dictionary
NHMD	National Hospital Morbidity Database
NHPA	National Health Priority Area
NCIS	National Coroners Information System
NISU	AIHW National Injury Surveillance Unit
QISU	Queensland Injury Surveillance Unit
RCIS	Research Centre for Injury Studies, Flinders University
SD	Standard deviation
UCoD	Underlying cause of death
US	United States
VEMD	Victorian Emergency Minimum Dataset
VISAR	Victorian Injury Surveillance and Applied Research System

List of Tables

List of Figures