Estimating morbidity associated with unintentional drowning episodes

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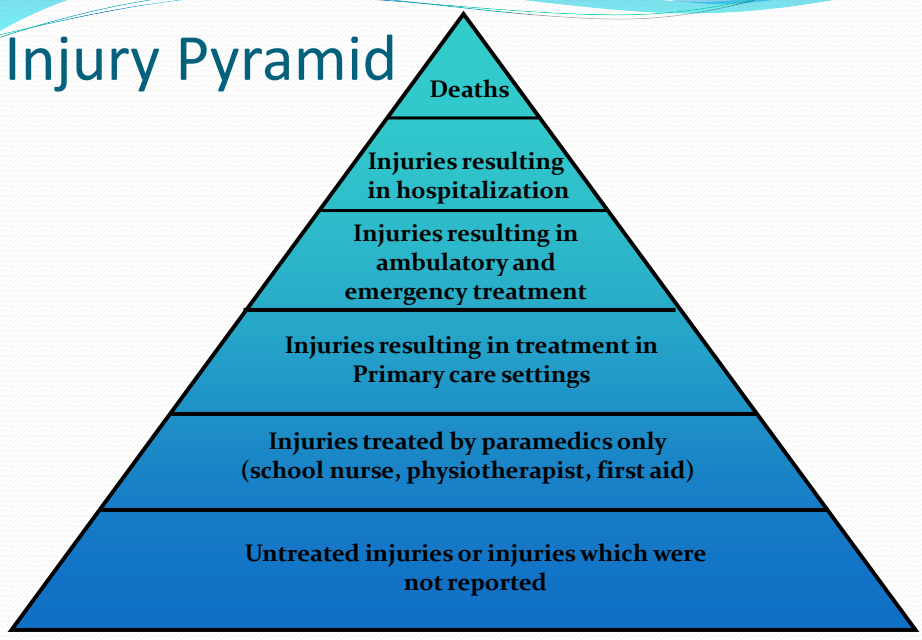
Why undertake the study?

- GBD Study
  - Estimate population level morbidity and mortality for specific injuries
  - Lack of available data at a country level
- Comparison with:
  - Other diseases / other countries
- WHO – funding
- Non-fatal and long term outcomes and burden
- Injury Pyramid
- Prevention

Table 1. **Leading Causes of Death, Both Sexes, 2000**

Rank	0-4 years	5-14 years	15-29 years	30-44 years	45-59 years	≥ 60 years	All Ages
1	Lower respiratory infections 2 134 248	Childhood cluster diseases 200 139	HIV/AIDS 855 406	HIV/AIDS 1 249 048	Ischaemic heart disease 931 267	Ischaemic heart disease 5 694 495	Ischaemic heart disease 6 894 057
2	Diarrhoeal diseases 1 315 412	Road traffic injuries 118 212	Road traffic injuries 354 692	Tuberculosis 368 501	Cerebrovascular disease 573 065	Cerebrovascular disease 4 312 376	Cerebrovascular disease 5 101 446
3	Childhood-cluster diseases 1 108 666	Drowning 113 614	Tuberculosis 238 021	Road traffic injuries 302 922	Tuberculosis 413 851	Chronic obstructive pulmonary diseases 2 285 834	Lower respiratory infections 3 866 321
4	Low birth weight 1 025 488	Lower respiratory infections 112 739	Self-inflicted injuries 216 661	Ischaemic heart disease 224 986	HIV/AIDS 332 996	Lower respiratory infections 1 225 643	HIV/AIDS 2 942 901
5	Malaria 905 838	Diarrhoeal diseases 88 430	Interpersonal violence 188 451	Self-inflicted injuries 215 263	Trachea, bronchus, lung cancers 275 895	Trachea, bronchus, lung cancers 886 787	Chronic obstructive pulmonary diseases 2 522 983
6	Birth asphyxia and birth trauma 787 179	Malaria 76 257	War injuries 95 015	Interpersonal violence 146 751	Cirrhosis of the liver 226 975	Hypertensive heart disease 754 495	Diarrhoeal diseases 2 124 032
7	HIV/AIDS 419 480	HIV/AIDS 46 022	Drowning 78 839	Cerebrovascular disease 145 965	Lower respiratory infections 226 105	Diabetes mellitus 612 725	Tuberculosis 1 660 411
8	Congenital heart anomalies 281 751	War injuries 43 671	Lower respiratory infections 65 153	Cirrhosis of the liver 135 072	Road traffic injuries 212 040	Tuberculosis 536 303	Childhood-cluster diseases 1 385 455
9	Protein-energy malnutrition 172 530	Tuberculosis 36 362	Poisonings 61 865	Lower respiratory infections 102 431	Diarrhoeal diseases 210 994	Stomach cancer 529 461	Road traffic injuries 1 259 838
10	STD's excluding HIV 142 176	Tropical cluster diseases 31 845	Fires 61 341	Liver cancer 84 279	Chronic obstructive Pulmonary diseases 181 458	Colon and rectum cancers 441 961	Trachea, bronchus, lung cancers 1 212 625
11	Drowning 119 922	Fires 30 599	Maternal haemorrhage 59 456	Poisonings 78 060	Liver cancer 180 263	Diarrhoeal diseases 400 705	Malaria 1 079 877
12	Anencephaly 85 247	Interpersonal violence 24 668	Rheumatic heart disease 48 062	War injuries 72 314	Self-inflicted injuries 165 412	Cirrhosis of the liver 385 886	Low birth weight 1 025 584
13	Meningitis 76 870	Leukaemia 23 808	Leukaemia 44 740	Nephritis and nephrosis 71 654	Stomach cancer 160 140	Nephritis and nephrosis 357 074	Hypertensive heart disease 940 818
14	Road traffic injuries 75 710	Poisonings 23 293	Nephritis and nephrosis 41 300	Diarrhoeal diseases 68 098	Breast cancer 145 200	Liver cancer 341 157	Self-inflicted injuries 814 778
15	Tuberculosis 67 372	Self-inflicted injuries 21 967	Diarrhoeal diseases 40 392	Breast cancer 61 480	Hypertensive heart disease 135 894	Oesophagus cancer 284 252	Diabetes mellitus 809 685

Injury Pyramid



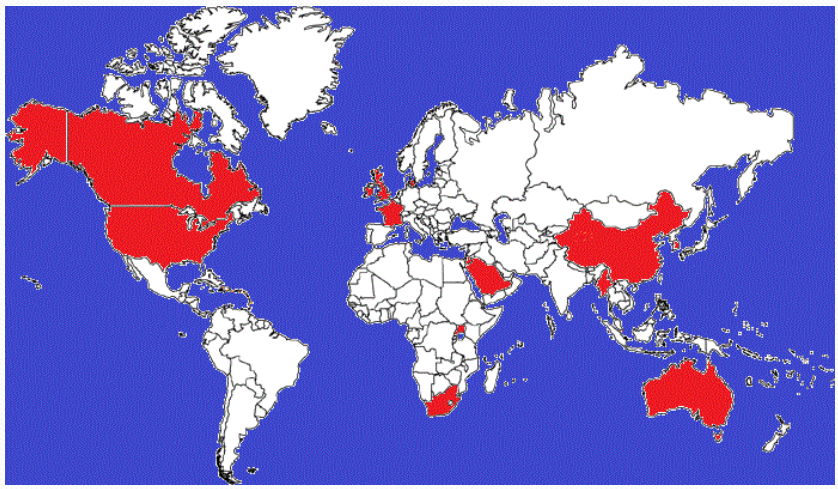
Methods

- Studies published in any language cited in:
  - MEDLINE; EMBASE; PsychINFO or SPORTSDISCUSS
- Published between January 1980 and December 2007 .
- Population-level studies that describe incidence or prevalence of nonfatal drowning episodes
- In GBD regions (n=21) or counties within a region,
- As well as studies that describe the progression of drowning consequences among survivors.
- Including studies on drowning related to natural disasters (e.g. floods, cyclones, tsunamis), water and other transport incidents.

Results

- The initial search strategy yielded 14,926 papers.
- After reading the title, 13,697 were discarded, leaving 1,229 papers.
- An additional 814 articles were discarded upon review of the abstract, leaving 367 papers for checking against the review criteria.
- Of these 367 articles, 159 were discarded, leaving 208 articles for data extraction.
- Only 57 of these articles included data on nonfatal drowning episodes, and only 12 articles focus solely on nonfatal drowning.
- Reasons for exclusion included: not population level data (e.g. case-series or occupation-specific); condition-specific studies (e.g. drowning in epilepsy); no primary data present; no numerical data present; study published prior to 1980.

Map of countries



GBD Region

GBD Region	No. of Articles retained for analysis	Range of morbidity rates (per 100,000)
Asia (Pacific, Central, East, South, Southeast)	4	? 1800
Australasia	7	2.55 – 45.21
Caribbean	1	4.9
Europe (Central, Western, Eastern)	10	1.2 – 2.4
Latin America	0	?
North Africa / Middle East	2	?
North America	29	0.77-6.1
Oceania	0	?
Sub-Saharan Africa (Central, East, Southern, West)	4	0-40.4
Total	57	0-45.21

Asia

- Study of hospital admissions (all drowning) 17 cases Goh & Low 1999
- Medical records of people >15 years of age Jung et al 2003
- Study of high school students (10-17 years) in China (Jia et al 2005) rate of near drowning 1800 per 100,000 for junior high school and 200 per 100,000 for senior high school, overall 1400 per 100,000 (self reported) – note: looked at a range of injuries
- Study by of school students in Thailand (Kozik) death 9/100,000 and near-drowning 868/100,000.
  - Have you fallen into water and almost drowned?
  - Can you swim 47%

TABLE I: CIRCUMSTANCES OF SUBMERSION INJURY IN VICTIMS

	Occurred at sea	Occurred at public pools	Occurred at private pool	Number
No. of cases	6	6	5	Total = 17
No. of witnessed drowning cases	5	6	4	Total = 15
No. not needing CPR	4	1	3	Total = 8
No. needing CPR (and presence of pulse or respiration)	2: - 1 apnoeic - 1 apnoeic & pulseless	5: - 3 apnoeic - 2 apnoeic & pulseless	2: - 2 apnoeic & pulseless	Total = 9
Any CPR received	1 immediate, 1 delayed	5 immediate (by life-guards)	1 delayed, 1 no CPR received	Total = 8 received CPR, 6 immediately

TABLE II: FACTORS AFFECTING OUTCOME OF PATIENTS

S/N	Age	Initial conscious state	Initial A&E cardiac rhythm	Initial spontaneous respiration	Immediate bystander CPR	Pupils	Neurologic outcome
1	21	Alert	Normal	Yes	Not needed	Reactive	Intact
2	19	Alert	Normal	Yes	Not needed	Reactive	Intact
3	8	Alert	Normal	Yes	Not needed	Reactive	Intact
4	21	Alert	Normal	Yes	Not needed	Reactive	Intact
5	30	Alert	Normal	Yes	Not needed	Reactive	Intact
6	32	Alert	Normal	Yes	Not needed	Reactive	Intact
7	43	Alert	Normal	Yes	Not needed	Reactive	Intact
8	31	Alert	Normal	Yes	Not needed	Reactive	Intact
9	20	Loss of consciousness few minutes**	Normal	No	Yes	Reactive	Intact
10	38	Unconscious*	Normal	No	Yes	Reactive	Intact
11	20	Loss of consciousness 5 minutes	Normal	No	Yes	Reactive	Intact
12	30	Loss of consciousness few seconds**	Normal	No	Yes	Reactive	Intact
13	13	Loss of consciousness few minutes	Normal	No	Yes	Reactive	Intact
14	10	Loss of consciousness few minutes	Normal	No	Yes	Reactive	Intact
15	9	Unconscious	Asystole	No	No	Unreactive	Hypoxic brain damage
16	50	Unconscious	Asystole	No	No	Unreactive	Died on arrival
17	11	Unconscious	Ventricular fibrillation	No	No	Unreactive	Died on arrival

* Was later diagnosed to have overdose of benzodiazepine, which would explain her inability to regain consciousness with CPR initially

** No pulse palpable when sought for by the initial CPR rescuer

Goh and Low 1999

Table 1. Characteristics of submersion accidents & patients

Characteristics	No. of case (%)	
Gender		
Male	23	(74.2)
Female	8	(25.8)
Age, yr		
15–24	10	(32.3)
25–34	2	(6.5)
35–44	6	(19.4)
45–54	6	(19.4)
55–64	0	(0.0)
≥65	7	(22.6)
Cause		
Inability to swim	12	(38.7)
Use of alcohol	10	(32.3)
Trauma	4	(12.9)
Seizure	1	(3.2)
Cerebral infaction	1	(3.2)
Suicide	1	(3.2)
Unknown	2	(6.5)
Type of water		
Fresh	22	(71.0)
Sea	6	(19.4)
Contaminated	3	(9.7)
Site of submersion		
River	9	(29.0)
Public bath	7	(22.6)
Sea	6	(19.4)
Ditch	4	(12.9)
Pond	3	(9.7)
Others	2	(6.5)
Season		
Spring	3	(9.7)
Summer	16	(51.6)
Fall	8	(25.8)
Winter	4	(12.9)

Cause

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Ditch	4	(12.9)
Pond	3	(9.7)
Others	2	(6.5)

Jung et al 2003

Australiasia

- Child 0-13 years of age 21.5/100,000 includes all drowning
  - 17.7 near and 3.9 death (Pitt & Balanda 19991)
- 84-94 Australia 20 near and 3 deaths in public pools in Brisbane and 145 and 20 deaths in home swimming pools (Injury Bulletin 1994)
- NT / Australia Drowning and near drowning 0-4 and 5-14 years 22.61 & 45.21, 3.21 & 5.56 (Edmond et al 2001)
- NSW 1992-1999 death = 1.5 / 100,000 and and 1995-1999 = 3.5 / 100,000 hospitalisation (Williamson & Schmertmann)

TABLE 1: Drownings and near-drownings of children in Brisbane South from July 1, 1984, to June 30, 1989

Age (years)	Total population††	Good outcome		Poor outcome*		Total	Annual rate (per 100 000 children)
		Boys	Girls	Boys	Girls		
0	8931	2	1	0	0	3	6.72
1	8832	14	18	5	2	39	88.32
2	9108	19	14	5	3	41	90.03
3	9495	4	5	0	0	9	18.96
4	9117	2	2	0	0	4	8.77
5–13	83 695	3	1	0	0	4	0.96
Total	129 178	44	41	10	5	100	15.48

*Drowned or suffered severe brain damage.

TABLE 2: Location of drownings and near-drownings of children in Brisbane South from July 1, 1984, to June 30, 1989*

Location	Primary residence	Other private	Public
Swimming pool	57 (11)	43 (4)	12 (2)
Bath	10 (2)	0	0
Pond	3 (1)	0	1 (1)
River or creek	1	0	1 (1)
Dam	2	2 (1)	0
Sea	0	0	3 (1)
Wading pool	1	0	0
Bucket	1	0	0
Drain	1	0	1 (1)
Total	76 (14)	45 (5)	18 (6)

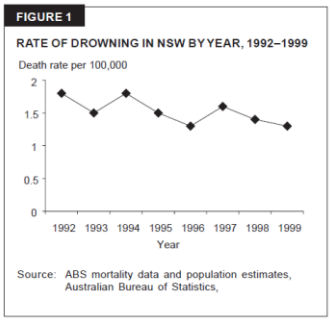
*Numbers in brackets indicate the numbers of children who drowned or who suffered severe brain damage.

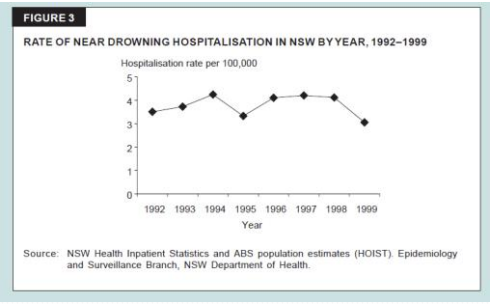
Pitt and Balanda 1991

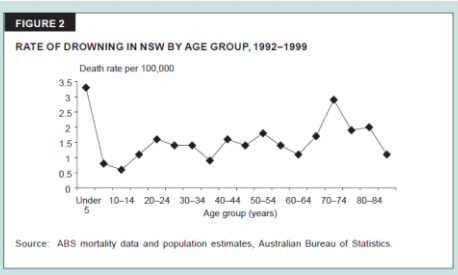
3: Average annual incidence of drowning and near-drowning for the rest of Australia and Queensland compared with the Northern Territory, 1994-1997

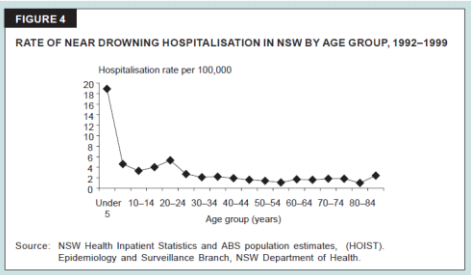
	Northern Territory		Australia		Queensland	
	Number	Incidence*	Incidence*	IRR† (95% CI‡)	Incidence*	IRR (95% CI)
Drowning						
0-4 years	16	22.61	3.71	6.17 (1.60-16.68)	5.77	3.92 (0.94-12.48)
5-14 years	1	3.21	0.62	5.26 (0.12-33.48)	0.82	3.91 (0.08-39.28)
Near-drowning						
0-4 years	32	45.21	20.69	2.19 (1.18-4.37)	26.78	1.69 (0.70-3.52)
5-14 years	7	5.56	2.55	2.20 (1.26-8.30)	5.36	1.03 (0.12-4.14)
Drowning and near-drowning						
0-4 years	48	67.82	24.45	2.77 (1.40-4.91)	32.55	2.13 (1.05-3.94)
5-14 years	8	6.44	3.61	1.78 (1.21-6.58)	6.12	1.04 (0.12-4.08)
Swimming pool drowning and near-drowning						
0-4 years	40	56.51	15.65	3.61 (1.70-6.77)	20.69	2.74 (1.24-5.47)
5-14 years	1	3.20	1.03	3.08 (1.75-18.7)	2.63	1.22 (1.29-8.23)

* Incidence per 100 000 children. † Incident rate ratio.









Williamson & Schmertmann 2002

Caribbean

- Barbados <4.9 per 100,000 (Corbin et al 1981
- Note age as an influence and also tourists

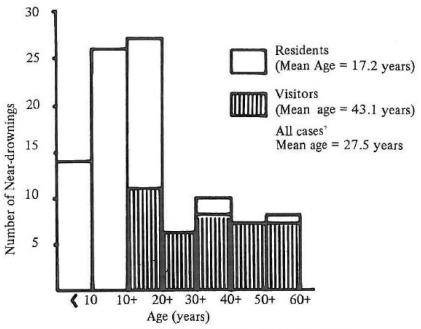


Fig. 3. Frequency distribution by age (near-drowning)

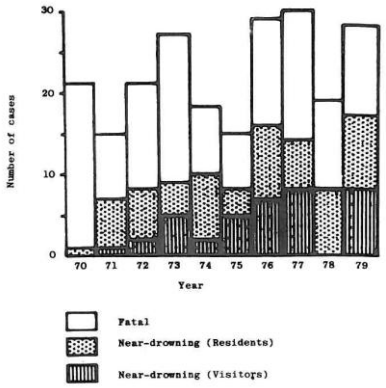


TABLE 1: Circumstances surrounding the near drowning event

Category	No. of cases (n = 81)
Recreational swimming	23
Documented alcohol intake	18
Heavy surf/strong current	13
Unsupervised child	7
Aquatic sporting activity	8
Attempt at rescue	4
Epileptic fit	5
Other acute illness	5
Accident at sea	1

Europe

- 17% of hospital admission death or handicapped Kemp & Sibert 1991
- Pederson et al 1990 – outcome and also intent
- France 1989 – 307 deaths to 15,402 rescues June -Sept
- 1.5/100,000 Kemp and Sibert 1992
- <3.2 / 100,000 Lindholm & Stensberg 2000 –
  - Include death and near and people who are cooled
- 1.3 / 100,000 Maurin et al 2006 – includes both death and near
- 1.2 / 100,000 Scallan et al 2004
- 2.0 – 2.4 / 100,000 Henderson & Wilson 2006 – hospital

Outcome in nearly drowned children according to accident and signs on admission to hospital

	No of children		
	Died	Handicapped	Fully recovered
Type of accident			
Drowning deaths	142		
Minor immersion			42
Serious immersion	16	10	120
Signs on admission after serious immersion			
Conscious			82
Impaired consciousness:			
Normal pupils	3		28
Fixed dilated pupils, respiratory effort			5
Fixed dilated pupils, no respiratory effort	13	10	5

Kemp and Sibert 1991 and 1992

Cases of drowning in children under 15 years of age in United Kingdom 1988-9 grouped according to site of incident (141 notified in 1988, 165 in 1989)

	Survivors near drowning	Drowning deaths	Total	Mean age
Bath	19 (1)*	25	44	1 year 2 months
Garden pond	48 (4)*	11	59	1 year 10 months
Domestic pool	15 (2)*	18	33	2 years 4 months
Private pool	10	8	18	5 years 9 months
River, canal, lake	17 (2)*	56	73	6 years 10 months
Public pool	30 (1)*	2	32	7 years
Sea	9	20	29	7 years 10 months
Other	9	9	18	4 years 2 months
Total	157 (10)*	149	306	

*Survivors who sustained severe neurological handicap.

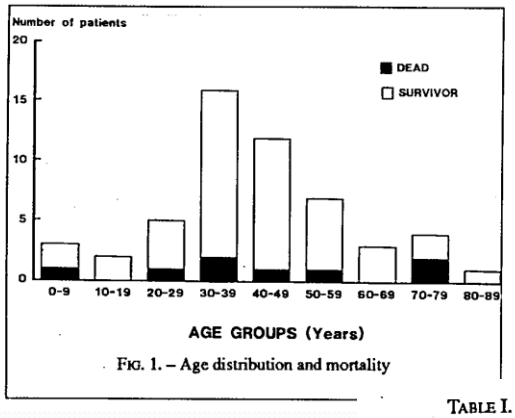


FIG. 1. – Age distribution and mortality

Pederson et al 1990

TABLE I. – *Mortality and cause of near-drowning*

Cause	No. of cases	No. of survivors (percentage)
Suicide	30	29 (97 %)
Accident	11	10 (91 %)
Murder	1	0 (0 %)
Unknown	9	4 (44 %)

Table 1 Cases of unintentional near-drowning and fatal drowning or cooling in water in Denmark in 1995 by age and gender

	Male		*Female*		*Total*	
Age (years)	*No*	*Incidence/ 100 000*	*No*	*Incidence/ 100 000*	*No (%)*	*Incidence/ 100 000*
0–4	14	8.6	12	7.0	26 (15.6)	7.8
5–9	8	5.6	6	4.0	14 (8.4)	4.8
10–14	5	3.7	2	1.4	7 (4.2)	2.6
15–24	12	3.5	2	0.6	14 (8.4)	2.0
25–34	15	3.8	4	1.0	19 (11.4)	2.4
35–44	16	4.4	5	1.3	21 (12.6)	2.8
45–54	25	6.7	3	0.8	28 (16.8)	3.7
55–64	8	3.1	1	0.4	9 (5.4)	1.8
65–74	12	5.0	5	2.5	17 (10.2)	3.9
75–84	5	3.0	5	4.7	10 (6.0)	3.6
85–94	1	1.7	1	4.2	2 (1.2)	2.4
Total (%)	121 (72.5)	4.6	46 (27.5)	1.8	167 (100)	3.2

Lindholm and Steensberg 2000

Table Leading causes of unintentional injury death and hospital admission

Cause	Unintentional injury deaths 1980–1996 *n* (%)	Rate (per 100 000 per year)	Unintentional injury hospital admissions 1993–1997 *n* (%)	Rate (per 100 000 per year)	Ratio deaths: admissions
Motor vehicle traffic accident	7964 (42.1)	13.3	32 351 (14.5)	179.4	1:13.5
Fall	3253 (17.2)	5.4	96 003 (42.9)	532.5	1:98.6
Drowning/submersion	1433 (7.6)	2.4	224 (1.0)	1.2	1:0.5
Fire/burn	1385 (7.3)	2.3	4504 (2.0)	25.0	1:10.9
Suffocation	867 (4.6)	1.4	758 (3.4)	4.2	1:3.0
Poisoning	780 (4.1)	1.3	16 191 (7.2)	89.8	1:69.1
Struck by, against	242 (1.3)	0.4	23 935 (10.7)	132.8	1:332.0
Cut/pierce	34 (0.2)	0.1	12 265 (5.5)	68.0	1:680.0
All unintentional injuries	18 925	31.6	223 561	1239.9	1:39.2

Scallan 2004 et al

Table 1: Count and percentage of episodes, occupied bed days and average length of stay by ICD Classification, 1997/8 – 2003/4

ICD 10 Code	*Episodes*	*%*	*Bed days*	*%*	*Average length of stay*
V90 Accident to watercraft causing drowning and submersion	56	0.8	102	0.3	1.9
V91 Accident to watercraft causing other injury	247	3.6	1223	3.8	5.3
V92 Water-transport-related drowning/submersion without accident to watercraft	245	3.6	895	2.8	3.8
V93 Accident on board water craft without accident to watercraft not causing drowning or submersion	1100	16.2	4872	15.1	4.6
V94 Other and unspecified water transport accidents	539	7.9	2007	6.2	3.8
W15 Fall from cliff	847	12.5	5644	17.5	7.0
W16 Diving/jumping into water cause injury other than drowning or submersion	1256	18.5	8262	25.6	6.7
W65 Drowning and submersion while in bath-tub	262	3.9	795	2.5	3.2
W66 Drowning and submersion following fall into bath-tub	96	1.4	439	1.4	4.9
W67 Drowning and submersion while in swimming-pool	303	4.5	489	1.5	1.7
W68 Drowning and submersion following fall into swimming-pool	137	2.0	499	1.5	3.8
W69 Drowning and submersion while in natural water	266	3.9	1125	3.5	4.7
W70 Drowning and submersion following fall into natural water	288	4.2	1102	3.4	4.2
W73 Other specified drowning and submersion	154	2.3	653	2.0	4.6
W74 Unspecified drowning and submersion	777	11.4	2731	8.5	3.9
X38 Victim of flood	127	1.9	884	2.7	7.6
X92 Assault by drowning and submersion	66	1.0	239	0.7	5.1
Y21 Drowning and submersion undetermined intent	61	0.9	559	1.7	11.9
Total	6793	100.0	32,520	100.0	5.0

Henderson and Wilson 2006

North Africa Middle East

- AL Moffada et al 2001 has a ratio of case and survival
  - 5/9 survived with CPR and 6/19 no CPR
  - Submersion time <5min 12/12 survived >5mns 0/16 survived
- Al-Talafieh et al 1999 – has condition when reach hospital, this may effect outcomes

Table 1 **Condition of the 34 patients on admission**

Condition of patient	No. of deaths	No. of live patients	% of live patients
Fully conscious and alert with mild respiratory distress	0	9	26
Respiratory distress and cyanosis	0	16	47
Apnoea, but with cardiac activity	0	3	10
Cardiorespiratory arrest	5	6	17

North America

- 2.6 – 3.0 / 100,000 Ellis et al 1995
- 1-4 year olds in swimming pools 11.2 / 100,000 Ellis and Trent 1997
- Urban Utah 1-4 year olds 17.1 / 100,000 Jensen et al 1992
- Predictors of survival and outcome Quan et al 1990
- New Jersey 0.46-5.07 depending on race and geographic location – Fife et al 1991
- Toronto Children 0-14 years 0-6.1 depending on year and gender Hu and Wesson 1994
- 0.77-2.14 / 100,000 Children 0-4 years 3.56-18.69 CDC 2004

TABLE 1—Patient Characteristics, by Site of Near Drowning, California, 1991

	No.[a]	Site, %			Rate/ 100 000	95% Confidence Interval
		Swimming Pool (n = 540)	Other Recreation (n = 180)	Bathtub (n = 86)		
All	806				2.8	2.6, 3.0
Sex						
Male	505	69	23	8	3.6	3.3, 3.9
Female	301	64	21	15	2.1	1.8, 2.3
Age group, y						
Under 1	74	36	4	59	12.6	9.7, 15.4
1–5	439	84	9	7	18.4	16.7, 20.1
6–12	80	71	28	1	2.8	2.2, 3.4
13–19	48	46	48	6	1.9	1.4, 2.4
20–35	79	33	66	1	1.0	0.8, 1.2
36+	86	44	47	9	0.8	0.6, 0.9
Race/ethnicity						
White	469	69	23	8	2.9	2.7, 3.2
Hispanic	188	64	18	18	2.4	2.1, 2.8
Black	74	70	12	18	3.6	2.8, 4.4
Asian/other	75	65	28	7	2.7	2.1, 3.2

[a]Excludes 59 cases of "other" near drownings, 7% of the total (n = 865).
Source. Data are from the California Office of Statewide Health Planning and Development's Hospital Discharge Data Program.

Ellis et al 1995

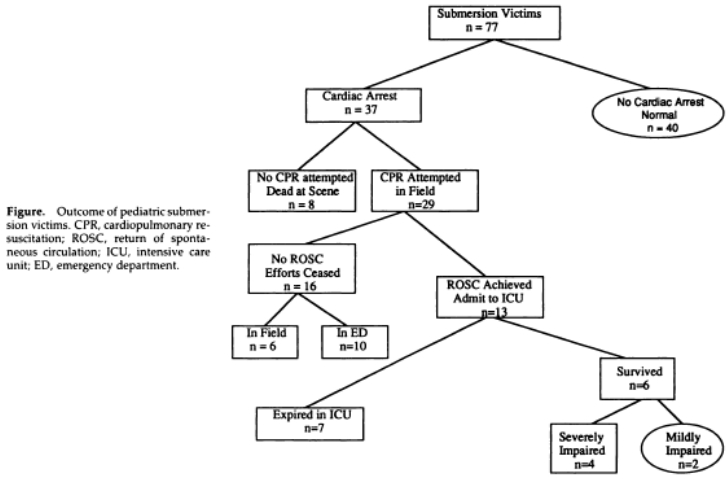


Figure. Outcome of pediatric submersion victims. CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation; ICU, intensive care unit; ED, emergency department.

Quan & Kinder 1992

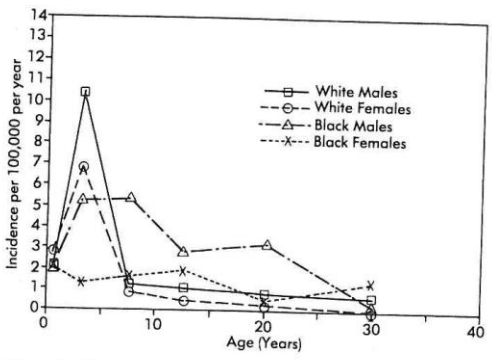


Figure 2. New Jersey nonfatal immersion injuries: incidence by age, sex, and race. The incidence of nonfatal immersion injury per 100,000 population per year was 2.02 (CI = 1.40–2.64) for black men, 1.28 (CI = 1.10–1.46) for white men, 0.83 (CI = 0.46–1.20) for black women, and 0.58 (CI = 0.46–0.70) for white women. Based on 41 nonfatal immersion injuries to black men, 194 to white men, 19 to black women, and 95 to white women.

Fife et al 1991

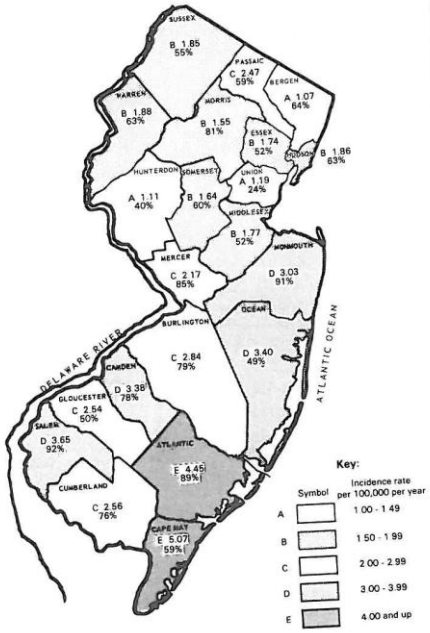


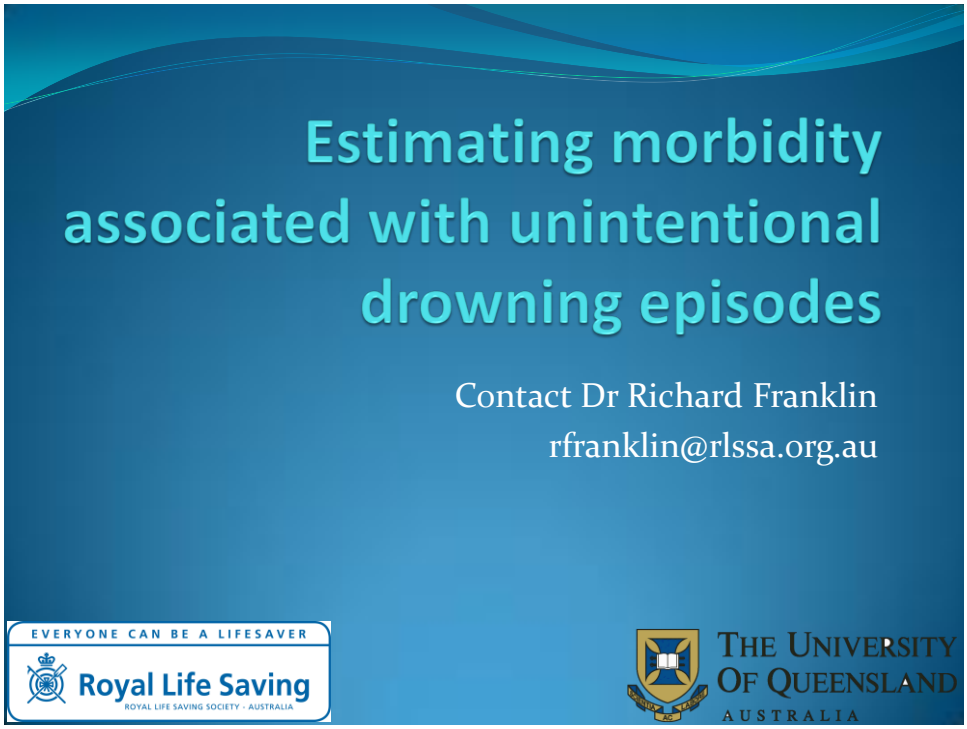
Figure 6. Immersion injury incidence rates and percentage occurring in-county by county of residence. For each county, the letter specifies the incidence rate group defined in the key, the letter specifies the incidence of (fatal and nonfatal)

Sub-Saharan Africa

- Uganda – 40.4 / 100,000 in rural, highest cause of death in rural populations if no other drowning incidents then 16.3 / 100,000 (Kobusingye et al 2001)
- Cape Town – 18 cases of 'secondary drowning' Dick & Potgieter 1982
  - ie development of acute respiratory insufficiency after apparently successful resuscitation from near-drowning.
- Gulu, Uganda – 0 (Lett et al)

What did we learn?

- Haven't found many articles at the end of the day
- Definition is important
- Variations by:
  - Region / Age / Types of water bodies / Gender
- When publishing a paper should include as a minimum:
  - Population exposed
  - Breakdown by age and gender
- Fatalities well describe but non- not well describe
- Need to do more research that both describes the problem but direct prevention
- Disasters add to count?


Estimating morbidity associated with unintentional drowning episodes
Contact Dr Richard Franklin
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EVERYONE CAN BE A LIFESAVER
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ROYAL LIFE SAVING SOCIETY - AUSTRALIA
THE UNIVERSITY OF QUEENSLAND
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