DAN Diving Fatality Workshop:

Developing and Evaluating Interventions Using Surveillance Data

Steve Marshall
Epidemiology
The University of North Carolina at Chapel Hill

Kristen Kucera
Occupational & Environmental Medicine
Duke University

Overview

- Surveillance
  - What is it?
  - Other systems
- Evaluating Interventions
  - Standard pre/post design (NCAA)
  - Case-crossover studies (hand injury)
- Application to Diving

Epidemiology

The study of the distribution and determinants of health related states or events in a population…

…and the application of this study to control of health problems

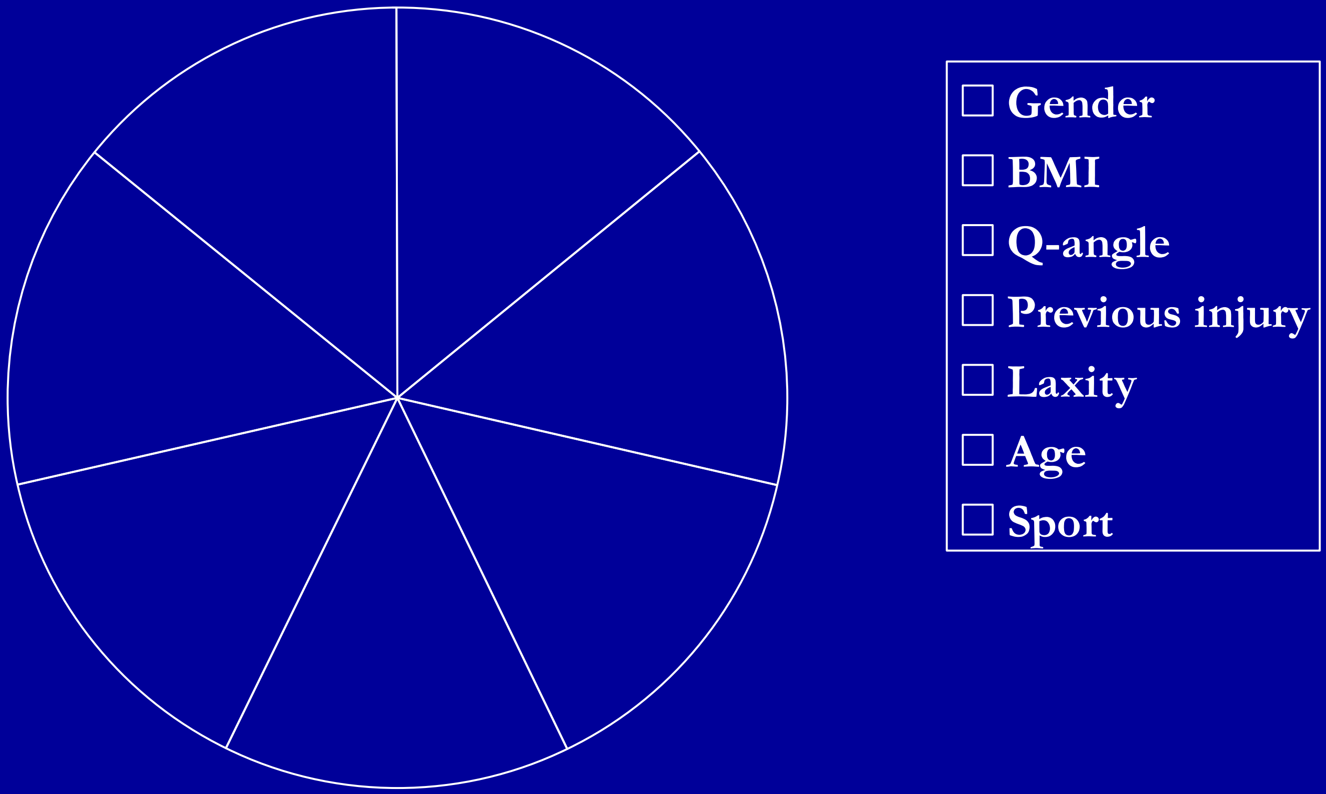
Associations

Risk Factor → Outcome

Gender → ACL injury

Gloves → Hand injury

Injuries have Multi-Factorial Causes: Example of ACL injury



Public Health Surveillance

Defined as the "ongoing systematic collection, analysis, and interpretation of data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know.“

Thacker SB, Berkelman RL. Public health surveillance in the United States. Epidemiol Rev. 1988;10:164–190.

Key Words

- “Ongoing”
- “Systematic”
- “Timely”

Purpose of Surveillance

- Identify trends in time, place, or person
  - Mortality and morbidity data
  - Disease outbreak notification
- Changes are observed and action taken
  - Investigative measures (e.g. ACL injuries)
  - Control measures (e.g. gloves)

Examples of Surveillance Systems

Fatal Injury (Census)

- Occupational: Fatality Assessment & Control Evaluation (FACE), Census of Fatal Occupational Injury (CFOI)
- Sports: National Center for Catastrophic Sports Injury Research
- Violent deaths: National Violent Death Reporting System
- Car crash: Fatality Analysis Reporting System (FARS)

Non-Fatal Injury (Samples)

- EDs: National Electronic Injury Surveillance System (NEISS)
- Sports: College - NCAA ISS, High School - RIO
- Police-reported car crashes: NASS

Overview

- Surveillance
  - What is it?
  - Other systems
- Evaluating Interventions
  - Standard pre/post design (NCAA)
  - Case-crossover studies (hand injury)
- Application to Diving

Collegiate Injury Surveillance: History

<u>Injury Surveillance System (ISS)</u>

NCAA developed in 1982
– National injury data collection tool for collegiate athletics
– Largest continuous collection of collegiate athletic injury data
– Converted to web-based data collection in 2004

Provides data to:
- Competitive Safeguards and Medical Aspects of Sports committee (advisory)
- Sport rules committees (legislative)

Operated by Datalys Center for Sports Injury Research and Prevention

Data + Access = Informed Decision Making

Individual schools volunteer to provide data

Athletic Trainers in each school collect data

Validation study of men's and women's soccer in 15 schools: reporting is 88% for injuries with $\geq$1day of time loss

Men’s Football Heat Injury

Men's Football Heat Injury

Trial begins for coach accused in player's death

STORY HIGHLIGHTS

- Former high school coach is charged with reckless homicide
- Player Max Gilpin, 15, died of heat exhaustion
- Player's body temperature hit 107 degrees at August '08 practice

updated 5:05 p.m. EDT, Mon August 31, 2009

Next Article in Crime »

TEXT SIZE

(CNN) -- Jury selection began Monday in Kentucky for the trial of a former high school coach charged with reckless homicide in the heat-exhaustion-related death of a player.

Pleasure Ridge Park football coach Jason Stinson has pleaded not guilty to reckless homicide.

A grand jury in January charged Pleasure Ridge Park football coach Jason Stinson in the death of Max Gilpin, 15, who collapsed during a practice in August 2008 and died several days later.

Stinson pleaded not guilty and was released without bail. The school has reassigned him to non-teaching duties.

The case has stirred strong feelings beyond the Louisville suburb where Gilpin died. Some say the teen's death was a tragic accident; others insist it was the result of a criminal act.

"The best example I can give you is like someone shooting into a building not knowing anyone is in there, then killing somebody," Commonwealth's Attorney R. David Stengel told CNN affiliate WHAS in January. "They didn't know they were in there, but they should have known that shooting into a building where people normally are is something dangerous."

Time Loss Heat Injury (TLHI) in the NCAA

- 95% of football TLHI occurred in preseason
- 85% of football TLHI occurred wearing full pads or helmets and SP
- 87% of football TLHI occurred on day with multiple practices
- 49% of ALL practice injuries over the entire season occurred during the 8-10 preseason multiple practice days.

Preseason Practice Policy Development Team

- Football coaches
- American Football Coaches Association (AFCA)
- Physicians
- Athletic Trainers
- Student-athletes
- Athletic Directors
- NCAA Staff

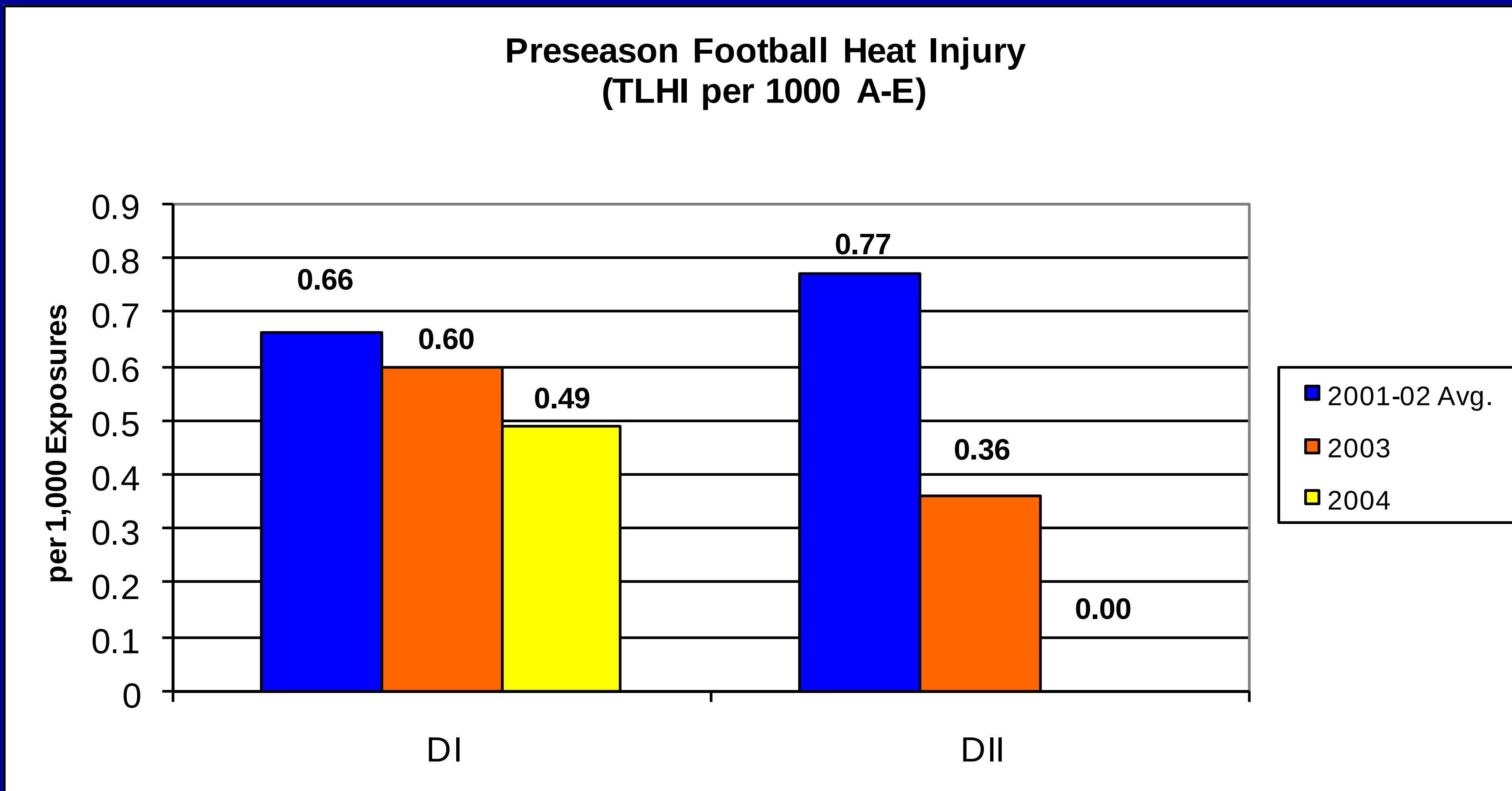
NCAA Football Preseason Practice Modifications

2003	2004
• No acclimatization period	• 5 day acclimatization period (1 practice, maximum 3 hours)
• No equipment limitations	• Days 1, 2: Helmets only • Days 3, 4: Helmets, Shoulder Pads • Day 5: Full equipment

NCAA Football Preseason Practice Modifications (cont'd)

2003	2004
• No sequencing multiple practices	• No consecutive multiple session days
• No required recovery time	• 3 hours recovery between practices
• No limit on practice length	• Single: Max 3 hours • Multiple: Max 5 hours

NCAA Football Preseason Practice Modifications



Results of Preseason Workout Survey

National Athletic Trainers' Association

"Our injuries were reduced by 2/3, I strongly recommend that we continue with the new format."

"Would like to see something similar instituted for men's and women's soccer and women's volleyball for August."

NCAA Football Preseason Practice Modifications

"I would say (the football conditioning package) is probably the most complete, heavily researched, thoroughly modeled – with total participation of all entities of any legislation that's ever been enacted by the NCAA…"

-Grant Teaff, executive director, AFCA

Overview

- Surveillance
  - What is it?
  - Other systems
- Evaluating Interventions
  - Standard pre/post design (NCAA)
  - Case-crossover studies (hand injury)
- Application to Diving

Case-Crossover Studies

- Observational (non-randomized or quasi-experimental) version of a clinical crossover study
- Key analytic question asked:
  "How unusual is it to have the transient exposure right before the onset of event?"
- Cases and controls are <u>dives</u>, not divers

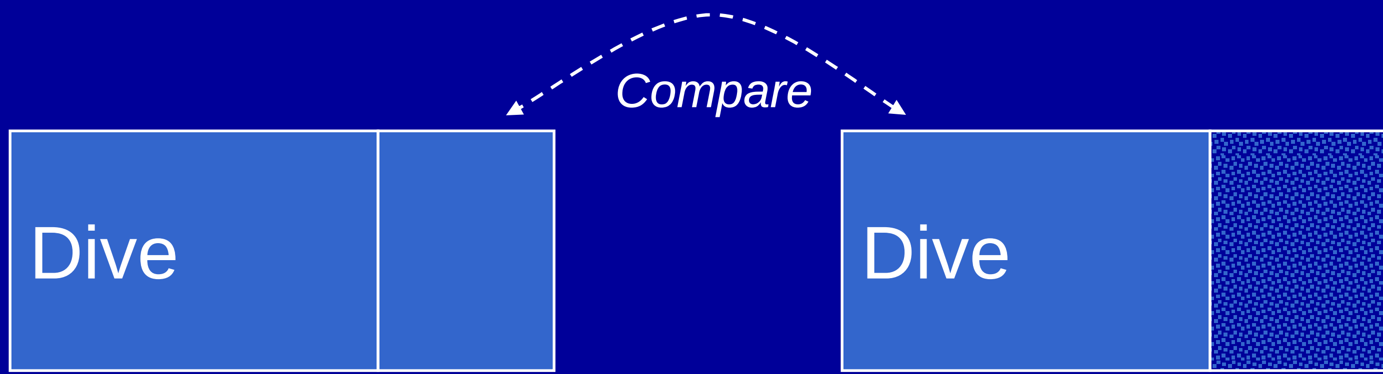
Case-Crossover Design

- Outcome of interest for cases include
  - Diving deaths, “near-misses”, DCI
- “Case times”
  - Period immediately before the onset of event
  - Triggers: hazardous diving conditions, diver fatigue, entanglement
- “Control times”
  - Previous dives of the subjects
  - Were conditions hazardous or were they fatigued on previous dives?

Pair-Matched Case-Crossover

Control time

Case time



<u>Trigger:</u>

Fatigued?

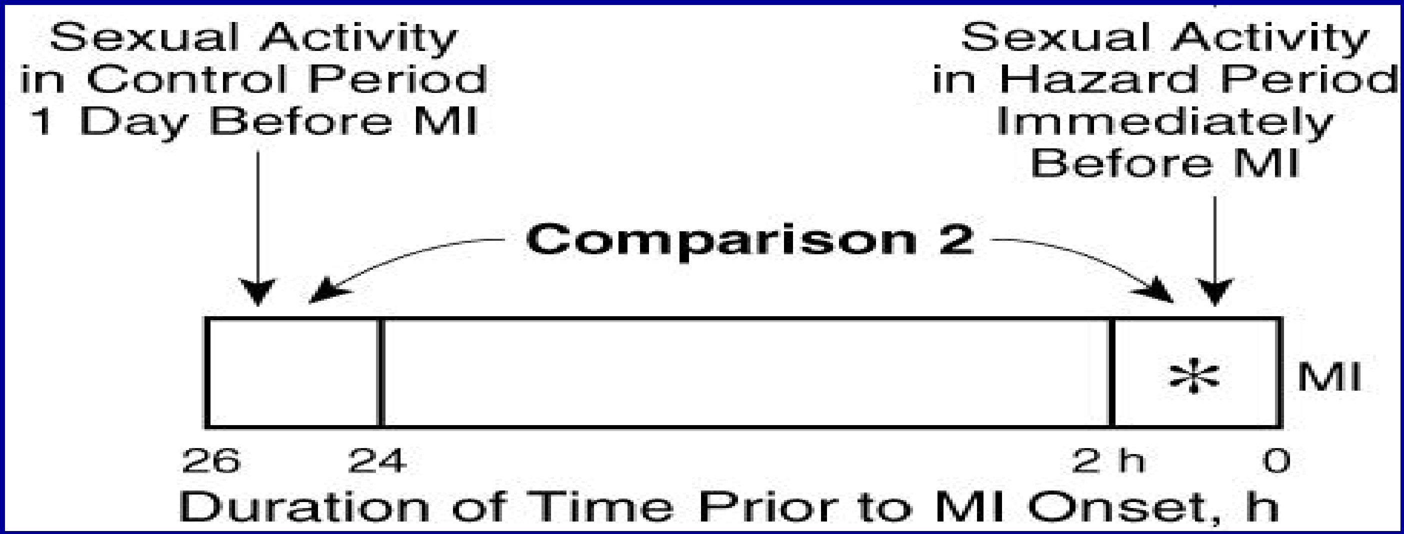
Entangled?

<u>Trigger:</u>

Fatigued?

Entangled?

Pair-Matched Case-Crossover



Muller *et al. JAMA 1996*

Advantages of Case-Crossover

- Subjects serve as own controls
  - Self-matched on individual-level confounders
  - Similar to clinical crossover

- Often easy to find case subjects
  - Emergency calls, diver deaths, DCI
  - Should represent a defined time/geographic population

- No need to recruit control subjects
  - Subjects provide both case times and control times
  - Compare exposure frequency in case times to exposure frequency in control times

Self-Matching

- Self-matching automatically adjust for ALL individual-level confounders
  - Including those that are not measured
- When there are:
  - No temporal trends in exposure prevalence over time
  - Confounders are NOT transient exposures
  - Does not control for confounders that are transient exposures, i.e. time trends in diving

Case-Crossover Design Applications

- To study the transient effect of intermittent exposure on rare acute event
  - CVD triggers (Maclure 1991)
  - Injuries (Roberts 1995; Mittleman 1997; Sorock 2004)
  - Pharmacoepidemiology (Schneeweiss 1997)
  - Infectious diseases (Dixon 1997)
  - Air pollution and acute CV effects (Neas 1999; Peters 2001)
  - Behavioral research (Seage 2002)
  - Health service research (Eriksson 2005)

Case-Crossover Study of Triggers for Hand Injuries in Commercial Fishing

Kristen L. Kucera, Dana Loomis, Stephen W. Marshall

Department of Epidemiology and the Injury Prevention Research Center,
University of North Carolina at Chapel Hill

Hypothesis

Do transient risk factors influence the risk of work-related commercial fishing hand injuries?

Background

- 22% to 52% of all fishing-related injuries are hand injuries

North Carolina Commercial Fishing

- Small-scale independent
- 7000 North Carolina licensed "to sell"
  - Underestimate
- North Carolina's top money crop
  - Landed 160 million pounds of fish and shellfish
  - Worth $94 million dollars in 2002

Methods:
Injury Definition

"Accidents or events that damaged your body, and required: first aid at the time of injury, or, medical care at some later time, or, time away from work."

Methods: Prospective Follow-up

- Weekly and biweekly phone interviews with 219 fishermen April 1999 to October 2001
  - Asked about weekly fishing work, exposures, and whether they were injured
- A case crossover study was nested within the prospective cohort
  - Study base = fishermen at risk for hand injury during 7-9 day interval while engaged in commercial fishing on or off the water

Methods:
Case and Control Definitions

Eligible case times:

- Interview periods where a hand/wrist/finger injury was reported

Self-matched control times:

- Interview periods where a hand/wrist/finger injury was NOT reported

Triggers:

- Maintenance work, glove use, >1 gear type, joint pain, location

Results: Hand Injury Events

- 46/217 fishermen reported 65 hand injury events (cases) during follow up
- Days between injury event and interview
  - 62/65 interviewed within a week
  - 55% interviewed within 4 days
- Severity of injury event
  - 60% no time off work, no external care
  - 22% no time off, some external care
  - 18% took time off work

Results: Hand Injuries by Part and Type

65 injury events; 72 separate injuries

- Part:
  - 53% finger
  - 32% hand
  - 7% thumb
  - 7% wrist
  - 1% multiple structures
- Type:
  - 46% laceration
  - 17% puncture
  - 15% abrasion
  - 7% contusion
  - 7% bite or sting
  - 3% sprain/strain
  - 3% burn
  - 3% other

Results:
Activity Prior to Injury Event

	n	%
Working with nets, pots, or lines	19	29%
Maintenance	17	26%
Working with catch	13	20%
Load, unload, trailer boat, dock, cast off, etc.	8	12%
Non-specific activities while commercial fishing	8	12%
Total	65	

Results:
Contact Cause of Injury Event

	n	%
Knife, hook or other sharp object	18	28%
Finfish, shellfish, or other sea animals	13	20%
Fishing gear	11	17%
Tools or equipment	10	15%
Other	9	14%
Falling on a hard surface	4	6%
Total	65	

Odds Ratios for Triggers of Hand Injury Events

Case matched to closest interview period (control)

	Case n=65	Control n=65	Unadjusted OR (95% CI)	Adjusted OR (95%CI)[1]
Maintenance work	39	30	2.3 (1.0 - 5.5)	2.2 (0.9 - 5.3)
Glove use	44	46	0.8 (0.4 - 1.9)	0.8 (0.3 - 2.0)
Worked on water	53	50	1.5 (0.5 - 4.2)	--
Joint pain	4	5	0.7 (0.1 - 3.6)	0.7 (0.1 - 3.7)
>1 fishing gear types vs. 0 or 1	15	10	2.2 (0.7 - 7.0)	2.0 (0.6 - 6.5)
Ocean vs. other location	7	8	0.7 (0.1 - 3.7)	0.8 (0.1 - 4.5)
Season : Apr to Oct vs. Nov to Mar	46	42	2.4 (0.6 - 8.8)	--

[1] Adjusted for all variables

Limitations

- Small sample size (n=65 cases)
- Injuries were not severe
- Case-crossover nested in cohort study
  - Didn't ask targeted questions regarding unusual tasks, alcohol or drug use, weather conditions, etc.
- Recall bias

Overview

- Surveillance
  - What is it?
  - Other systems
- Evaluating Interventions
  - Standard pre/post design (NCAA)
  - Case-crossover studies (hand injury)
- Applications to Diving

Applications to Diving: Case-Crossover

- Diving outcomes
  - Fatality, “near-miss”, DCI
- Case times (dives)
  - Registries, insurance claim, survey, medical records
- Control times (dives)
  - Abstracted from dive logs or records for fatalities
  - Obtained from records of case “near-misses”
  - Next of kin or dive buddy (“usual frequency”)

Improving Diving Data

- Data collection process
  – Definitions and missing data
- Defining the population at risk* (denominator)
- Diving frequency and duration*
- Information dissemination
- Evaluating diving interventions*

Defining the Population at Risk

- Number of divers
  - Insured members (e.g., DAN)
  - Certified/trained divers (e.g., PADI)
  - Clubs (e.g., British Sub-Aqua Club)
  - Population-based estimates (e.g., tourists, census survey – National Sporting Goods Association)
- Number of dives
  - Individual dive log or computer
  - Number of tank fills from dive shops
  - Number of charter boat trips
- Exposure duration
  - Hours from dive log or profile
  - Estimated via charter boat captain or dive master

Diving Safety Issues

- Training
  - PADI, NAUI, etc.
- Screening
  - Cardiovascular disease, diabetes, etc.
  - Other age and sex-related risk factors
- Supervision and equipment
  - Point of sale (e.g., proof of certification at tank fill)
  - Buddy system and/or dive master
  - Equipment checks
- Regulation

Evaluating Interventions

- Do current practices/interventions work?
- Formulating and implementing new practices/interventions
- Interventions are delivered in different countries, among different groups in different ways…

Barriers to Intervention

- Oversight and jurisdiction
- Fear of lawsuits
- Higher insurance rates
- Increased time to train divers
- Recognizing risks will scare away new divers

- Important to consider, and if possible, address when planning and implementing

Summary

- High-quality surveillance data is important for monitoring trends and informing interventions
- Analytic epidemiologic studies such as pre/post or case-crossover can be "spun off" surveillance systems

Thank you!