

Recommendations

As a result of this safety study, the National Transportation Safety Board made the following safety recommendations:

To the Manufacturers of Personal Watercraft (Kawasaki, Yamaha, Polaris, Bombardier, and Arctic Cat, Inc./Tiger Shark)—

Evaluate personal watercraft designs and make changes to improve operator control and to help prevent personal injuries. Consider items such as off-throttle steering, braking, and padded handlebars, and operator equipment such as personal flotation devices and helmets. (M-98-85)

Develop, with the U.S. Coast Guard, comprehensive standards that are specific to the safety risks of personal watercraft. (M-98-86)

To the U.S. Coast Guard—

Eliminate the existing process of exempting personal watercraft from standards that were defined for conventional boats and develop, with the personal watercraft manufacturers, comprehensive standards that are specific to the safety risks of personal watercraft. (M-98-87)

Determine within 2 years, through research, the feasibility of providing personal watercraft operators more control in an off-throttle steering situation. (M-98-88)

Work with the Personal Watercraft Industry Association to use the results of off-throttle steering research described in Safety Recommendation M-98-88 to develop appropriate standards for steering on jet-pump propelled vessels. (M-98-89)

Develop, in conjunction with the National Association of State Boating Law Administrators and the Personal Watercraft Industry Association, a checklist for boat rental businesses to use for evaluating a person's ability to operate a personal watercraft. (M-98-90)

Collect recreational boating exposure data such as "operational use time" or "vessel running time" and update this information on an annual basis or conduct periodic surveys. (M-98-91)

*Both stated
By manufacturers
or their Reps.*

The Clients are also involved in ongoing regulatory activities by the United States Coast Guard and the National Transportation Safety Board ("NTSB") concerning investigation and analysis of PWC-related accidents and injuries. The Clients further anticipate that these ongoing regulatory proceedings could lead to litigation between them and the Coast Guard and/or NTSB.

Counsel have concluded that their respective Clients have common legal interests and may assert common claims and defenses in connection with legal issues or actions that may arise from the NOAA, Coast Guard, and/or NTSB proceedings ("identified proceedings"); and that the mutual interests of their respective Clients will be advanced by cooperating in the legal representation and defense of their products, including sharing documents, factual material, mental impressions, memoranda, reports, data and other information, including the confidences of their Clients ("Defense Materials"), relating to the identified proceedings.

This Agreement memorializes the existing understanding among Counsel with respect to the identified proceedings and anticipated litigation. Counsel have agreed upon the following understandings:

1. The common interests of the Clients will be served by cooperation among Counsel in the identified proceedings, including the sharing of Defense Materials.

The Underestimated Impact of Personal Watercraft Injuries

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The popularity of personal watercraft is steadily increasing, as are injuries related to their use. Many of these injuries are not reported to law enforcement agencies, and available personal watercraft injury statistics are suspected to be inaccurate. All personal watercraft-related injuries treated within a four-hospital system (including the regional Level I trauma center) between January 1993 and December 1997 were retrospectively identified. Patient demographics, accident mechanism, injuries sustained, tourist status, outcome, and economic data were collected and compared with available government statistics for the same time period. Sixty-eight consecutive patients injured during personal watercraft use were identified. Of these, 78 per cent were treated and released, whereas 22 per cent required inpatient management. Fractures and soft tissue injuries were the most common injuries sustained. Ninety-seven per cent of patients were discharged home. There was one fatality. Comparison with state and federal statistics identified that personal watercraft injuries are significantly underreported and have an estimated yearly economic impact of more than \$235 million. Personal watercraft injuries represent an increasing source of watersport-related trauma. Government statistics on personal watercraft injuries do not accurately reflect the true incidence and economic impact of such trauma. Mandatory educational programs and increased legislation to improve personal watercraft safety should be promoted.

THE POPULARITY OF personal watercraft (also known as "jet-skis" or "waverunners") is steadily increasing among all age groups.¹⁻³ There are now more than 1,000,000 personal watercraft in operation in the United States.¹ With their expanding popularity, the incidence of personal watercraft accidents resulting in physical injury is also increasing.¹⁻¹⁵ A recent Centers for Disease Control and Prevention study reported a fourfold increase in personal watercraft-related injuries between 1990 and 1995, with an estimated yearly accident rate of 16.2 injuries per 1000 personal watercraft in operation.¹ The true incidence of personal watercraft accidents, however, is unknown, as many of these accidents are not reported to local or state law enforcement agencies.^{1,3,12} The United States Coast Guard estimates that only 2.5 to 10 per cent of nonfatal boating accidents are reported; no such data exist for personal watercraft accidents (Bruce Schmidt, Office of Boating Safety, United States Coast Guard). Government statistics are there-

fore suspected to significantly underestimate the incidence of personal watercraft-related injuries.

To better determine the true incidence of personal watercraft-related injuries, a retrospective review of all personal watercraft-related injuries treated in a four-hospital healthcare system in Central Florida was performed. Data were then compared with state law enforcement agency statistics to evaluate the accuracy of personal watercraft accident reporting. On the basis of these data, an assessment of the economic impact of personal watercraft-related injuries on society was made.

Methods

All personal watercraft-related injuries treated within the Orlando Regional Healthcare System from January 1993 to December 1997 were retrospectively identified using E-codes 830.0 to 838.9. Orlando Regional Healthcare System primarily serves a four-county region of Central Florida, which is a major worldwide tourist destination, as well as a popular area for recreational boating. During the study period, Orlando Regional Healthcare System included the regional Level I trauma center, the regional children's hospital, and two hospitals that serve the majority of tourists requiring medical care in the region. Patient demographics, accident mechanism, injuries sustained [including Injury Severity Score (ISS)], tourist status,

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hospital length of stay, patient outcome, and hospital charges were abstracted from each patient's chart. Patient data were then compared with state statistics maintained by the Florida Department of Environmental Protection, Division of Law Enforcement to determine which injuries had been reported to state law enforcement authorities. Personal property damage estimates were also obtained from the state.¹⁶⁻¹⁹ Data were evaluated using standard descriptive statistics and Student's *t* test where appropriate. Significance was defined as $P < 0.05$.

Results

Sixty-eight consecutive patients injured as a result of personal watercraft accidents were identified. Of these, 45 (66%) were male and 23 (34%) were female. Eleven patients (16%) were tourists, of which many were noted to have had limited personal watercraft experience. Mean age (\pm standard deviation) was 26 ± 10 years with a range of 7 to 69 years. Sixty patients (88%) were 35 years of age or younger. Fifty-three (78%) of the injured were treated and released, whereas 15 (22%) required inpatient hospitalization. Four patients (6%) required admission to the intensive care unit. Those individuals requiring inpatient hospitalization were more severely injured than outpatients (mean ISS, 13 vs 3; $P = 0.004$). Tourists tended to have more significant injuries than local residents (mean ISS, 8 vs 5; $P = 0.32$). Youth (age ≤ 16 years) tended to be more severely injured than adults (mean ISS, 9 vs 4; $P = 0.15$). Those patients with presumably less experience in operating personal watercraft (*i.e.*, tourists and youth) had significantly greater injuries than did adult residents (mean ISS, 10 vs 3; $P = 0.02$). Table 1 lists the mechanisms of injury as well as the injuries sustained.

TABLE 1. Mechanism and Injuries Sustained

	%
Position on personal watercraft	
Operator	87%
Swimmer	10%
Passenger	3%
Mechanism of injury	
Single personal watercraft	62%
Collision with another personal watercraft	25%
Collision with a boat	7%
Collision with a dock or pier	6%
Injuries sustained*	
Soft tissue (lacerations, contusions)	70%
Fractures	28%
Closed head injuries	13%
Liver laceration/contusion	3%
Renal laceration/contusion	3%
Splenic laceration/contusion	2%

* Multiple injuries are common.

Sixty-six (97%) of the patients were discharged home. Of the remaining two patients, one French tourist was transferred to a hospital in Paris for ongoing care and rehabilitation after sustaining a severe pelvic fracture. The single fatality was a 69-year-old woman who, while vacationing in Orlando, rented a personal watercraft with her family and collided with a dock, sustaining a grade V splenic injury. Hospital and intensive care unit length of stay for those requiring inpatient care were 4.4 ± 3.5 and 3.6 ± 4.8 days, respectively. The mean hospital charge was \$22,075 for inpatients and \$904 for outpatients. Hospital charges for tourists were \$35,370 for inpatients and \$1,492 for outpatients, reflecting their higher severity of injury.

Study data were compared with Florida Department of Environmental Protection, Division of Law Enforcement personal watercraft accident data. Only 8 per cent of the personal watercraft injury patients treated within the Orlando Regional Healthcare System during 1996 were known to have been injured by state law enforcement. Using 1996 United States Coast Guard statistics and a reporting rate of 10 per cent, 40,910 personal watercraft accidents were estimated to have occurred nationwide in 1996.²⁰ Utilizing an injury-to-accident ratio of 80 per cent (based on 1993-1997 State of Florida personal watercraft accident statistics), 32,728 personal watercraft-related injuries per year were calculated.¹⁶⁻¹⁹ On the basis of average personal property damages of \$1,320 per accident, average inpatient charges of \$22,000, and average outpatient charges of \$900, the economic impact of personal watercraft injuries on American society was calculated at more than \$235 million dollars per year.¹⁶⁻¹⁹ (Table 2).

Discussion

Personal watercraft are small Class A inboard boats powered by two-stroke gasoline engines. They do not have propellers, but rather use a water pump for propulsion. The first modern personal watercraft was introduced in 1974 by the Kawasaki Motor Corporation as the "jet ski." It had a 32-horsepower engine, traveled at peak speeds of 30 mph, and required the user to stand upright, demanding practice and coordination to operate. Since that time, the number and types of personal watercraft available to the public have grown dramatically. Current personal watercraft may contain engines of up to 135 horsepower, can accommodate from one to three riders, are able to tow skiers behind them, and can achieve speeds in excess of 60 mph. These speeds, coupled with their relatively low price compared with other powered watercraft, ease of launch and recovery, and maneuverability have contributed to their increasing popularity. Ninety-eight

TABLE 2. Socioeconomic Impact of Personal Watercraft Injuries

	State of Florida 1996	United States	
		1996 (Reported)	1996 (Estimated)
Accidents	464	4,091	40,910
Injuries	389	1,831	32,728
Deaths	4	57	57
Personal property damages	\$466,321	NA	\$54 million*
Health care charges	\$1.6 million	NA	\$181 million*
Economic impact			\$235 million*

NA, not available.

* Calculated from study patient data and government statistics.

per cent of all personal watercraft are now of the sit-down variety in which the operator and passenger(s) ride seated as on a motorcycle. This design modification significantly reduces the skill and expertise required to operate these vehicles, making personal watercraft accessible to all ages and levels of experience.

Table 3 lists a compilation of all previous studies (other than case reports) in the area of personal watercraft injuries. The majority of injuries sustained as a result of personal watercraft use are lacerations, contusions, sprains, and fractures. Closed head injury and intra-abdominal injury occur with less frequency. When present, however, these injuries are frequently devastating because of the high velocity and rapid deceleration involved.¹⁴ Although comprising only 2 per cent of the current series, personal watercraft fatalities across the United States have increased dramatically over the past decade, from 5 deaths in 1987 to 57 in 1996.²⁰ This 1100 per cent increase is almost certainly related to the marked increase in the number of personal watercraft on the nation's waterways as well as the significantly increased speeds these craft are capable of achieving. Perhaps this explains why personal watercraft operators are injured 8.5 times more often than those operating other motorized watercraft.¹ Shatz et al.¹⁴ have illustrated the significant

potential for fatal injury in these accidents as a result of both intrathoracic and intra-abdominal injury. Barach and Baum¹⁵ have recently emphasized the exponential increase in both injuries and fatalities associated with the increasing speeds of personal watercraft.

It is difficult to assess the true incidence of personal watercraft accidents due to the poor reporting rate associated with these mishaps. Although fatal and serious injuries are believed to be reported fairly consistently, nonfatal injuries, which comprise the majority of personal watercraft accidents, are likely reported less than 10 per cent of the time. Despite the fact that it is a felony under Florida law to not report a personal watercraft accident-related injury, our finding that only 8 per cent of personal watercraft injuries were reported to state law enforcement agencies correlates well with the United States Coast Guard estimate.²¹ Our calculation of more than 32,000 personal watercraft-related injuries per year nationwide is also in close agreement with the assessment of the Centers for Disease Control and Prevention based on data from the National Electronic Injury Surveillance System.¹ Unfortunately, these data are no longer being collected, and future estimates of personal watercraft injuries using this method will not be possible.¹⁵

We believe that the calculated economic impact of

TABLE 3. Personal Watercraft Injury Literature Review

Reference	Patients	Deaths	Injuries Sustained				Home
			Fractures	Intra-Abdominal	Closed Head Injury	Soft Tissue	
Vernberg et al. ⁸	13	2			15%		
Jeffery and Caiach ⁴	6	0	66%	33%	33%	33%	
Francis and Vize ³	37	0	27%	11%	0%	62%	
Hamman et al. ^{12*}	59	0	29%	2%	17%	76%	
Swinburn ⁵	6	1	50%		33%	66%	
Jones ⁶	57	4	13%				
Shatz et al. ¹⁴	37	12†	46%		14%		80%
ORHS	68	1	28%	6%	12%	72%	96%

ORHS, Orlando Regional Healthcare System.

* All patients <25 years of age.

† Includes ten fatalities in the field.

personal watercraft-related injuries on society is an underestimate. In these calculations, a personal watercraft accident-reporting rate of 10 per cent was utilized. As the 8 per cent reporting rate in this study demonstrates, the actual percentage of personal watercraft accidents reported to state and federal agencies is likely less than 10 per cent and may be as low as 2.5 per cent. The higher reporting rate used in the calculations may contribute to a significant underestimate of the true economic impact of these injuries. Hospital cost data were unfortunately unavailable. Although the use of hospital charges likely inflates the economic calculations, the financial implications of personal watercraft-related injury on society remain significant. It should be noted that these calculations do not include the cost of rehabilitation, disability benefits, or the loss of productivity in the American workplace.

Youth, inexperience, and recklessness appear to play a significant role in the etiology of personal watercraft accidents.^{2-4, 6, 8, 12-14} Nearly 50 per cent of accidents in Florida involve operators with less than 20 hours of experience.¹⁶⁻¹⁹ The present study further confirms the suggestion made in previous studies that youth and inexperience contribute to significantly more severe injuries than in experienced personal watercraft operators.^{1, 12, 15} Several previous authors have strongly recommended more stringent legislation with regard to minimum age and hours of training for personal watercraft operators.^{1, 2, 6, 15} Currently, the State of Florida statutes mandate that personal watercraft operators must be at least 14 years of age and use a personal flotation device at all times.²² Specific training in personal watercraft safety is not required. We would propose, as have others, that the minimum age be increased to 16 years and that mandatory educational classes be required for all personal watercraft operators. Some states have already enacted such legislation, whereas others are currently considering it.^{2, 6} Minimum age requirements should be applied to both personal watercraft owners and renters alike. Personal watercraft should be considered the "motorcycles of the waterway" because of their high speeds and lack of protection. Their use should be subject to the same limitations as those placed on motor vehicle operators. Mandatory licensing of personal watercraft operators should be instituted just as would be required should these individuals desire to drive an automobile or motorcycle. Consideration should be given to mandating the use of helmets and/or foot protection as are used during personal watercraft demonstrations and competitions. Legislation should further be enacted to protect the significant number of swimmers and other bystanders who are injured as a result of reckless personal watercraft use.^{8, 12, 15} Most importantly, improved reporting of personal watercraft accidents and

injuries should be mandated and enforced to provide the statistics necessary to support such legislation.

Personal watercraft-related injuries represent a rapidly increasing source of watersport-related trauma. This study represents the largest series to date of personal watercraft-related injuries treated in a single institution. Operators with inadequate experience are at significantly increased risk for sustaining physical injury and even death. Personal watercraft injuries are clearly underreported, and the financial impact on society is underestimated. Educational programs and closer regulation of personal watercraft should be promoted. Improved communication between health care centers and state law enforcement agencies is necessary to accurately identify the magnitude of this public health problem.

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