Snowsport Helmets: The Good and Bad

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Inherent Risks in Snow Sports
Head Injuries in Snow Sports

• 4% to 12% of all injuries

• Potential outcomes: minor to severe

• Death or devastating permanent cognitive issues

• $\frac{2}{3}$ of fatalities involve a head injury
Wear a Helmet

- Shell
- Foam liner: Energy attenuating Comfort
- Chin strap
Outline for Talk

- Helmet Use and Head Injury Statistics
- Helmet Capabilities & Limitations
- Influence of Helmets on Fatality Risk
Takeaway Points

1. Ski helmets reduced minor and potentially serious head injuries

2. Ski helmets have not reduced (and cannot reduce) fatal injuries
U.S. Helmet Use on the Rise

Overall Helmet Utilization

Percent Utilization

Season
U.S. Helmet Use: 02/03 – 12/13

Percent Utilization

Age Group

Season
U.S. Helmet Use by Age

Percent Utilization

Season

Age Group
Canadian Helmet Use: 2012-2013

Percent Utilization vs. Age Group
Sugarbush - Helmet Use Trend

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Sugarbush - Head Injuries

Mean Days Between Injuries

Better Better Better Better

Worse Worse Worse Worse

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Helmets
Capabilities and Limitations
Limitations

• Helmets only protect the head
• Limited amount of impact mitigation capability
• Does not protect against all types of head injuries
Head Motion for TBI

Linear Acceleration

Angular Acceleration
Linear Acceleration Injuries

- Skull fracture
- Coup brain injuries
  - At the site of impact
- Contrecoup brain injuries
  - On the side opposite of impact
- Localized injuries
Angular Acceleration

- Shearing injuries
  - Diffuse Axonal Injury
  - Bridging vein rupture (subdural hematoma)

- Injury not necessarily at or opposite to site of impact

- Diffuse injury
Common Head Injury Mechanism

Opposite-edge phenomenon

− Nakaguchi et al. (2002)

Usually: Ⓞ Ⓟ
When Can a Helmet Help?

Conducted testing to find out

- Back edge catch (snowboarding)
- Impact with a fixed object
Methods

• On-slope speed measurements
  – Average speed = 18 mph

• Indoor Test Facility
  – Falls onto a snow surface
  – Obstacle strike

• Crash Test Dummy
  – Instrumented head
  – Helmeted
  – Unhelmeted
Helmet Testing Equipment

• Helmets
  – Various makes/models
  – Fit to the dummy head

• Snow Surface
  – Soft, spring snow
  – Hard packed and icy snow

• Fixed obstacle
  – 11-inch diameter wooden pole
Helmet Testing Procedure

- Slope of 20°
- ~19 mph impact speed
Results - Five phases of a fall
Results – Head Accelerations

Ave Max Head Acceleration (Gs)

- Soft Snow
- Icy Snow
- Obstacle (tree)

Helmet vs. No Helmet
Results – HIC$_{15}$

- **Soft Snow**
  - Helmet: 0 ms
  - No Helmet: 0 ms

- **Icy Snow**
  - Helmet: 1,500 ms
  - No Helmet: 12,000 ms

- **Obstacle**
  - Helmet: 12,000 ms
  - No Helmet: 12,000 ms

The graph shows the average 15ms HIC score for different conditions and helmet use.
Results – Probability of Brain Injury

- **Soft Snow**
  - No Helmet: 0%
  - Helmet: 0%

- **Icy Snow**
  - No Helmet: 75%
  - Helmet: 25%

- **Obstacle (tree)**
  - No Helmet: 100%
  - Helmet: 100%
Testing Conclusions

• Hard, icy snow:
  – Helmets likely help

• Soft snow:
  – Helmet may not be needed
  – Still a good idea

• Hit a tree or lift tower
  – Not likely to make a difference
Has Increased Helmet Use Decreased Fatalities?
Do Helmets Reduce Fatalities?

• Most fatal ski accidents involve an enormous amount of energy

• Energy attenuating capability of a helmet

Hypothesis:
A helmet may alter the pattern of death, but not the ultimate outcome.
Skiing Fatalities

- Following analysis based on publicly available media reports (not death certificates)
- 2000-2001 to 2004-2005 seasons
- Found 215 fatalities
- 58 had data on helmet use AND primary cause of death
Primary Cause of Death

• Head injury as primary cause of death 2.3 times more likely for non-helmeted fatalities

• Wearing a helmet had no overall effect on fatalities

• Pattern in leading cause of death changed
Helmet Use and Fatality Rates

- **SB Rate**
- **Ski Rate**
- **Per Cent Utilization**
- **Linear (SB Rate)**
- **Linear (Ski Rate)**

R² = 0.0001
R² = 0.0009

Season: 91/92, 92/93, 93/94, 94/95, 95/96, 96/97, 97/98, 98/99, 99/00, 00/01, 01/02, 02/03, 03/04, 04/05, 05/06, 06/07, 07/08, 08/09
Conclusion

• Use of helmet will alter primary body part

• No data to support increased helmet use will decrease fatality rate

• For incident scenarios associated with fatality, more than a helmet is needed to avoid death
Thank You