Some parts of this paper are under review for Wilderness and Environmental Medicine Journal. Submitted to the 2011 International Technical Rescue Symposium.

Rock Climbing and Gravity: Timing, Causes and Injuries in Boulder County, Colorado.

Daniel A. Lack, PhD; Alison L. Sheets, MD; David C. Christenson, MSc
Rocky Mountain Rescue Group, P.O. Box Y, Boulder, Colorado, USA, 80306

P.O. Box Y, Boulder, Colorado, USA, 80306
contact@RockyMountainRescue.org
www.RockyMountainRescue.org

1 Introduction

There are many popular rock climbing areas around the world, but few locations have sufficient concentrations of both easily accessible climbing areas and large numbers of local rock climbers to make regular collection and analysis of accident data viable. The American Alpine Clubs, Accidents in North American Mountaineering provide statistics on injury and occurrence of fatalities for over 6,200 accidents and 11,300 victims, covering the years 1947 to 2007, while statistics exist for all US National Parks (1992 – 2007) [1], Yosemite National Park [2] and Australia (302 accidents over 50 years) [3]. Here we augment this data with 13 years (1998-2010) of statistics covering 316 mountain rescue missions and 386 victims in Boulder County, Colorado. Much anecdotal evidence exists within the climbing community regarding the most common causes and types of injuries climbing accidents. In this report we present the most common types and causes of climbing morbidity and mortality. In addition, we compare the broader statistics of Boulder County (with multiple climbing areas), to a specific climbing location within Boulder County, Eldorado Canyon State Park.

2 Methods, Definitions and Clarifications

The data presented was collected for missions to which RMRG was requested through the emergency 911 dispatch system. Some accidents with near misses or minor injuries likely go unreported to SAR. The collected data includes information on the types, locations, and causes of the injuries and accidents. Data was collected from rescue reports, which are completed at the time of, or shortly after rescue missions. This review covers the years 1998 – 2010 and includes all rescues involving accidents while rock climbing or at climbing areas, which we define as including technical roped climbing, un-roped climbing (free-soloing or scrambling), mountaineering, bouldering or bystanders at climbing areas. Victim injuries were classified according to the most severe injury noted, regardless of other less severe injuries sustained. As some climbing rescues involve more than a single victim, statistics are presented by climbing victim rather than by climbing SAR rescues. We present data from Eldorado Canyon State Park in some of the figures. To illustrate the differences between a specific climbing area (ECSP) and more general climbing region (Boulder County), the percentages provided for ECSP are referenced to the number of rescues in that area. Although some detailed investigations into the circumstances of serious climbing accidents have been performed [e.g. 4] this report focuses on presenting the accident trends, causes, and injury.

3 Results

3.1 General Overview

Since 1998, RMRG has responded to 316 climbing rescues, assisting 386 victims. On a yearly average this is 18±5% of all rescues (1711 total rescues) or 19±8% of all victims (Figure 1a). On average, technical roped climbing accounts for just 8% of total rescues. Year to year variability in climbing accidents as a percentage of total rescues can be large, with 42% of victims being involved in climbing accidents for 2010 compared to 11% for 1999, 2003 and 2009.

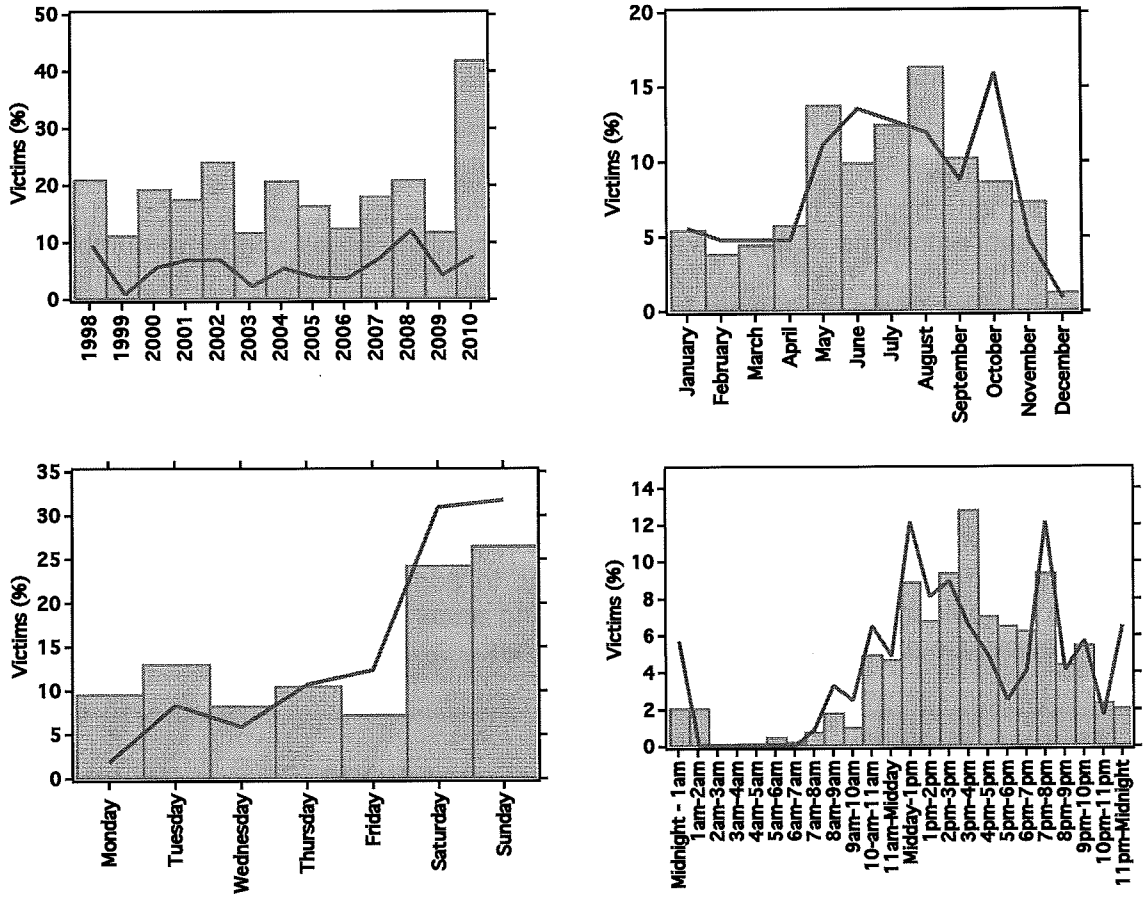

Figure 1; RMRG 1998-2010 climbing accident statistics by a) % of total victims involved in climbing accidents, b) climbing accident victims by month, c) climbing accident victims by day of week, d) climbing accident victims by rescue initiation time. Eldorado Canyon statistics shown in red lines.

3.2 Accident circumstances / timing

The distribution of climbing accident victims by month (Figure 1b) shows that most accidents occur in Summer (36%) followed by Fall (32%), Spring (23%) then Winter (9%). About 50% of victims result from accidents that occur on the weekends, with each mid-week day accounting for about 10% of accident victims (Figure 1c). Accident timing (time of SAR activation) is also normally distributed across the hours of 8am to midnight, with a median time of 2-3pm (Figure 1d). The distribution changes significantly when considering just Eldorado Canyon State Park by itself with an increasing trends in accidents from Monday through to the weekend, and two distinct modes of accidents

occurring; one in mid afternoon and the other around 7 – 8pm. Of all climbing rescues, 57% of victims were involved in technical roped climbing and 34% were un-roped climbers. Bouldering accounts for 6% of victims while 1% of victims were mountaineering and a further 1% were involved in rock fall accidents at climbing areas (while not actively climbing) (Table 2 and Figure 2a). For Eldorado Canyon 90% of victims were involved in technical roped climbing while only 6% were un-roped.

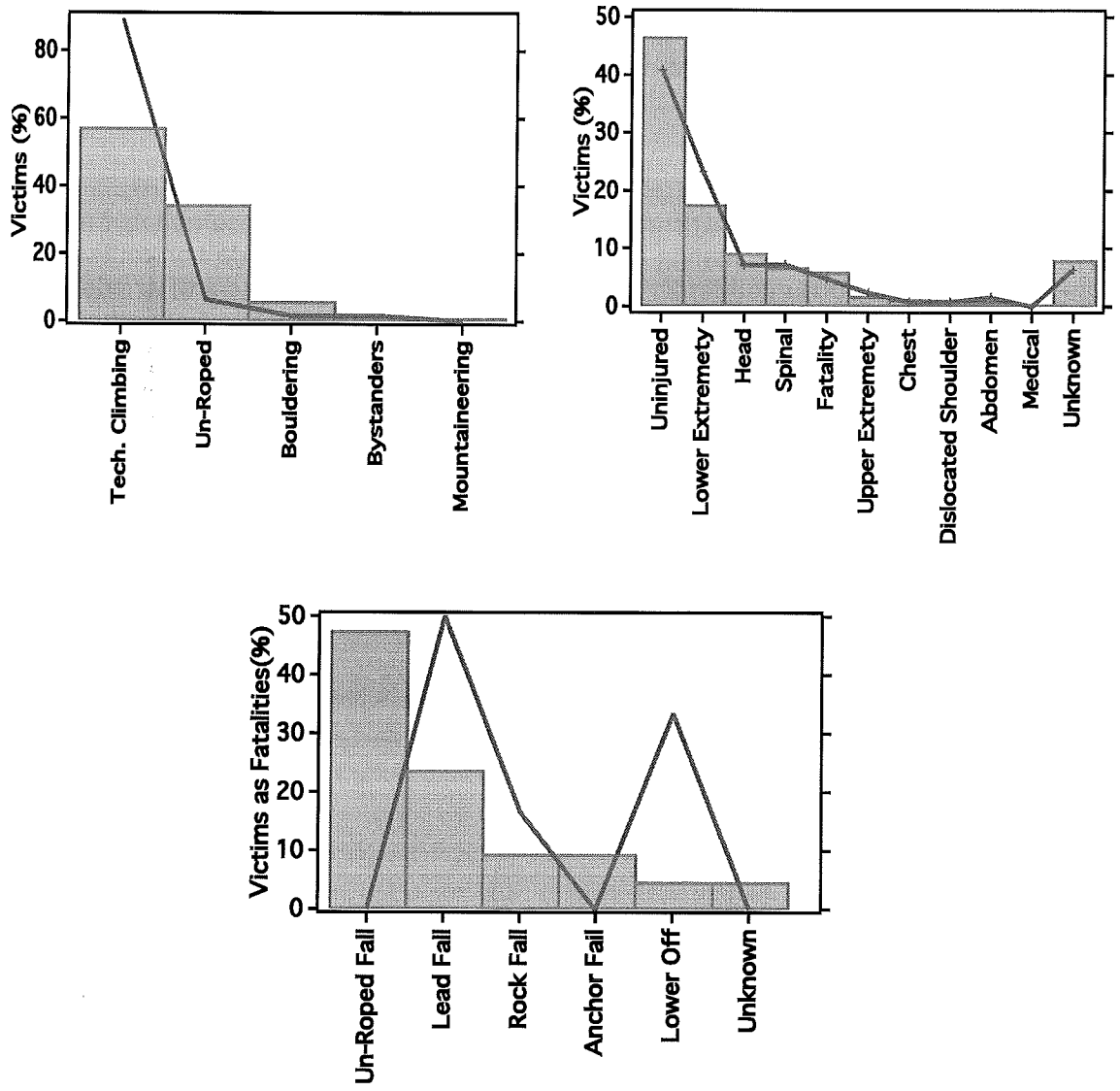

Figure 2; RMRG 1998-2010 climbing accident statistics by a) Distribution of climbing victims by climbing activity, b) distribution of climbing victims by injury type, c) Distribution of climbing fatalities by accident cause. Eldorado Canyon statistics are shown in red lines.

3.3 Injuries accident patterns

The most common cause for a climbing rescue mission is an uninjured but stranded or lost climber (47% of victims, Figure 2b). The most common situation where climbers get stranded is when undertaking un-roped climbing (88% of stranded climbers). However roped climbers become stranded for a variety of reasons as well (e.g. knees wedged in cracks, unclear on rappel descent routes). The most common climbing injury involves

the lower extremity (ankle, tibia/fibula, knee) (18% of victims), while the upper extremities (fingers, hand, radius/ulna, humerus) account for 2% of climbing victims. Injury patterns do not change for ECSP. Climbing fatalities comprised almost 6% of climbing victims (23 in total). Of the non-fatal injuries head and spinal injuries are the next most common injury (9% and 7% of climbing victims respectively). Of the fatalities (22 in total), 39% were from un-roped climbing (Figure 2c), 22% from lead falls, 9% from anchor failures, 9% from rock fall, and 13% from being lowered off the end of the rope. There were 6 fatalities in ECSP with none of them a result of un-roped climbing. The fraction of fatalities as a percentage of all climbing related accidents in Boulder County is 6%. The fraction of fatalities from technical roped climbing is 7%.

3.4 Technical Roped Climbing

For all rescues of persons involved in technical roped climbing, 45% were a result of a lead fall or second fall (Figure 3a) compared to 29% of victims that became lost during down-climbs/walk-offs, necessitating SAR assistance. Climbers stranded on routes but otherwise uninjured accounted for 21% of victims. A less common cause of accidents for technical roped climbing is anchor failure, which resulted in 4% of victims over the last 13 years.

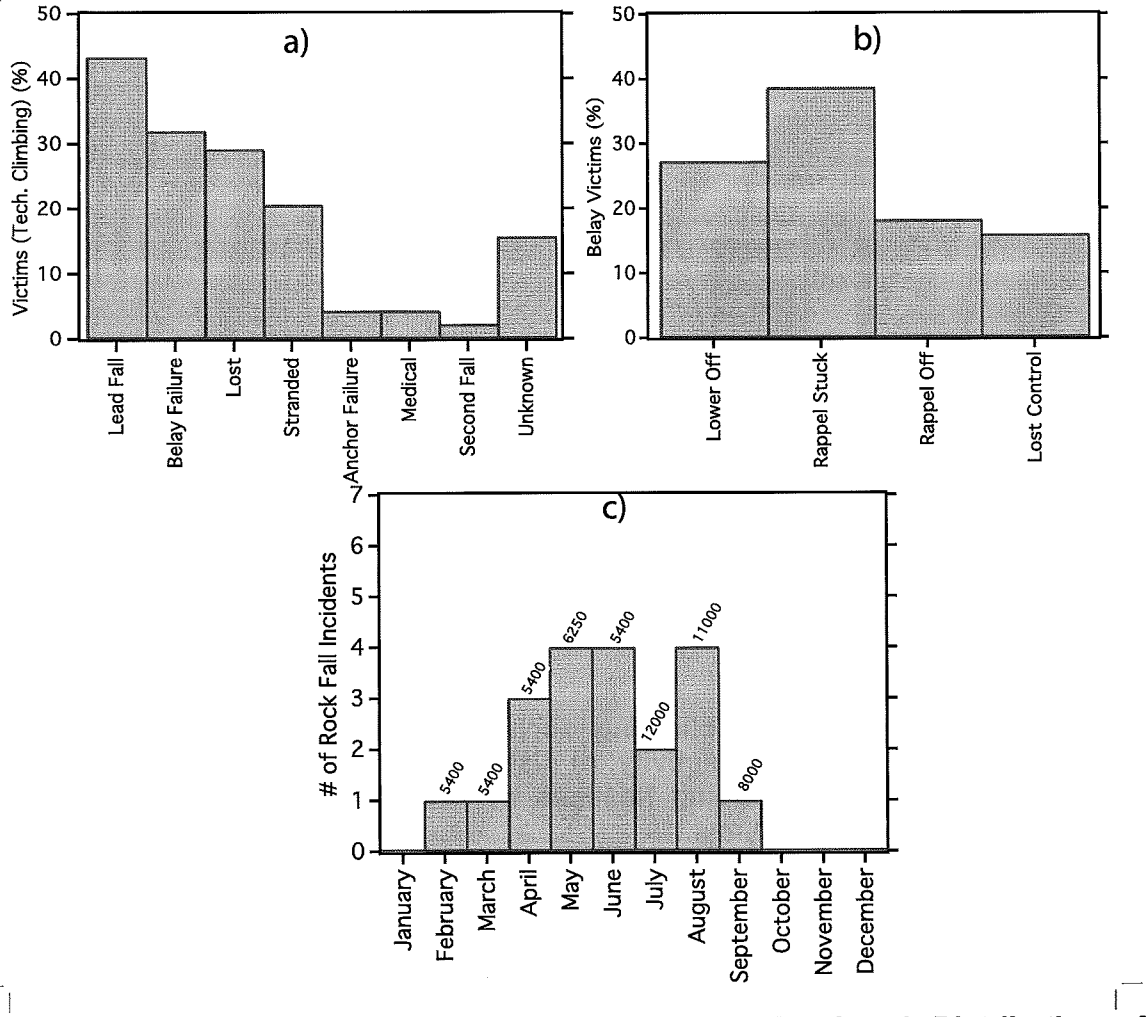

Figure 3; RMRG 1998-2010 climbing accident statistics by a) Distribution of technical roped climbing victims by cause, b) Causes of injury to victims in belay

related accidents, c) Rock-Fall incidents by month, with average altitude at which the incident occurred provided above the bar for each month.

3.5 Un-Roped Climbing

Un-Roped climbing is the second most common climbing activity requiring rescue (34%, Figure 2a), and most often leads to uninjured but stranded victims. It must be noted that the statistics sometimes do not record experience level; therefore, it is not always possible to differentiate between inexperienced 'scramblers' and experienced free-solo climbers. An un-roped climber is also the most common victim involved in fatal accidents, with almost 39% of fatalities resulting from this activity (Figure 2c). Very few accidents (6%) in ECSP are a result of un-roped climbing.

3.6 Belay Related Accidents

11% of accident victims were a result of a belay related accident or were lowered off or rappelled off the end of their rope (Figure 3b). Belay accidents involving falls in a top-rope configuration (top-rope climbing or lowering the lead climber after a successful ascent) or a configuration where the rope was not long enough for the climber to reach the ground accounted for 43% of victims, 75% of whom had severe or fatal injuries and 13% of whom received severe rope burns while belaying. Only 16% of accident victims resulted from a belayer losing control of the rope where sufficient length of rope was available.

3.7 Rock Fall Accidents

5% of all climbing victims were a result of climbers or bystanders at climbing areas being hit by, or falling off a climb, as a result of falling rock. Rock fall accidents have mostly occurred during the freeze thaw cycles of Spring (for lower elevations) and Spring/early Summer (for higher elevations) (Figure 3c). Figure 3c also shows the average elevation (feet above sea level) where the accidents occurred. Boulder sits at 5400 feet above sea level (ASL) while the highest peaks RMRG responds to are, at most, ~14000 feet ASL. The accidents in February - June occurred at an average elevation of ~6000 feet ASL while those in July, August and September occurred at elevations above 8000 feet ASL. The accidents during August are at an average elevation of 11000 feet ASL.

4 Discussion

19(±8)% of the people RMRG rescues each year are involved in climbing accidents, which compares to 19% climbing related rescues performed annually by Yosemite Search and Rescue (YOSAR) [5]. The fraction of fatalities from technical roped climbing is 7% for RMRG compared to 6% reported for Yosemite National Park reported by Bowie et al. [2]. Sedgman [3] report a fatality rate for technical roped climbing victims in Australia of 14% and a lead-fall fatality contribution of 40% (compared to 7% and 22% here). For RMRG, over 45% of all technical roped climbing victims are a result of a lead fall or second fall compared to about 64% from the data of Sedgman [3] and 60% from the data of Heggie and Amundson [1]. Almost 50% of RMRG climbing accident victims were lost or stranded on a climb or during descent from a climb. Anchor failure contributed to just 4% of technical roped climbing victims for RMRG. Almost 35% of all RMRG climbing accident victims were free-solo climbing which most often leads to stranded, uninjured victims, however 39% of all climbing fatalities result from free-soloing. Sedgman [3] also report a high rate of free-soloing fatalities: 36% of all climbing fatalities within their data. Belay-related climbing accidents account for 21% of RMRG

technical roped climbing victims, while rock fall accidents contributed to 5% of all RMRG climbing victims. Five of the accidents within this report involved rock releasing from steep slopes (rather than on climbs themselves) at climbing areas or on popular mountaineering routes; most of these incidents were during the prime freeze/thaw cycle. As a final conclusion, we find no evidence of an increase in the fraction of climbing related rescue victims across the 13 years of this study (19±8% per year).

5 Acknowledgments

The authors would like to acknowledge the contributions of the Rocky Mountain Rescue Group personnel involved in the rescues covered in this analysis of 13 years of data. Specific thanks to Steve Chappell, Clint Dillard, Jake Entin, Drew Hildner Tom Moyer, Les Sikos, Bijan Tuysserkani, Kevin Vranes and Dale Wang for helpful comments.

6 References

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