victim was breathing when extricated from a depth of 3 m (9.8 ft) after 100 minutes. However, he was unconscious and severely hypothermic with an epitympanic core temperature of 22°C (71.6°F). The second skier was found a few minutes later in asystole without an air pocket. He was declared dead by the emergency physicians on site, according to the ICAR avalanche guidelines.

The first patient was intubated and transported to the nearest hospital by helicopter. During transport he went into ventricular fibrillation. He continued to be ventilated, but chest compressions were not administered for 15 minutes. Initial attempts at defibrillation at the destination hospital were unsuccessful because of hypothermia. He was subsequently transferred to a referral hospital where he could be placed on cardiopulmonary bypass. He was successfully resuscitated and rewarmed. He eventually made a complete neurologic recovery.

Had there been few rescuers rather than the many who actually responded and had the AvSORT algorithm been applied, the first victim would have been triaged to the "immediate treatment" category and transferred to a trauma center. However, if ventricular fibrillation had started before he was placed in the helicopter and the second victim had not yet been found, the first victim would have been triaged or retriaged into the category of "expectant" management and would have received no further treatment. The result would have been a fatal outcome rather than the complete recovery he actually experienced.

Until the authors of the AvSORT algorithm can produce convincing data to show that their proposed triage method would increase survival in multi-casualty avalanche incidents, rescuers should resuscitate potentially live victims who have already been found and not divert necessary medical resources to further searching.

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In Reply to Avalanche Triage

To the Editor:

In reply to the letter by Dr Ken Zafren, we take this opportunity to resolve any confusion with the use of the Avalanche Survival Optimizing Rescue Triage (AvSORT) algorithm.¹

On February 1, 2003 in backcountry Canada, 2 mountain guides watch with horror as an avalanche engulfs and buries a school group of 17 participants below them.^{2–4} They immediately realize their priority for rescue is to uncover as many victims as possible prior to the onset of asphyxia. They "cannot save everybody"⁴ but must focus on "the greatest good for the greatest number."^{5–11} They decide, as 2 rescuers, they will only dig enough to allow resumption of breathing, to clear airways, and to hand responsive victims their own shovels for self-extrication before moving on. They recognize that to stop and attempt cardiopulmonary resuscitation (CPR) on any one asphyxiated victim will seriously compromise the survival of other victims still buried. The first victim, recovered in the first 5 minutes, is the school teacher who calls on his satellite phone for outside organized rescue. As the avalanche debris sets up "like concrete,"⁴ victims who are not buried too deep are uncovered while deep burials are passed over due to the pressure of time. One victim goes on, after fully extricating himself, to locate and uncover 3 of his classmates, resulting in their survival. The first rescue helicopter lands after 55 minutes and of the 17 buried victims 10 survive. The rational action of the 2 mountain guides is credited with the survival of the majority of these victims in this mass casualty avalanche incident.^{3,4} The development of our proposed AvSORT algorithm is a result of this and other similar incidents that we cite in the text of our article. This algorithm is designed for the "initial management of mass casualty avalanche incidents when manpower is overwhelmed."¹ We must re-emphasize this.

By comparison Dr Zafren cites an incident in which 3 helicopters with 15 rescuers, 2 emergency physicians, and 2 dog handlers are on scene for 2 buried victims, 1 of whom survives.¹² This would never be considered a

mass casualty avalanche incident and it would be highly inappropriate to apply our proposed AvSORT algorithm to this event. We must re-emphasize “it is not designed for situations where resources allow for standard resuscitation and treatment of all extracted individuals, such as in the International Commission for Mountain Emergency Medicine (ICAR MedCom) ALS algorithm.”¹

As stated above, our AvSORT algorithm is derived from experience in the, fortunately few, mass casualty avalanche incidents and by merging concepts from the START⁶⁻¹¹ algorithm and the ICAR MedCom ALS algorithm.¹³ We acknowledge there are no with-control outcome data for our AvSORT algorithm. Likewise, although the use of the START algorithm has been documented in the September 2001 World Trade Center attack and many other high-profile mass casualty events, “there are no data in these descriptive papers regarding whether the system was used correctly or improved outcomes.”¹⁰ The ICAR MedCom algorithm, which was originally proposed in 2001 and which we and Dr Zafren cite, has only recently been analyzed in a systematic literature review.^{14,15} These three valuable tools have been derived from descriptive accounts and should be scrutinized with future experience but would unlikely be examinable by prospectively designed controlled trials. However, they have not been developed in a “data vacuum.”

The prime value of companion rescue to avoid asphyxia from prolonged burial is undoubted¹⁶ and is the principle embodied in the AvSORT algorithm. In this we agree with Dr Zafren, but we disagree with his statement that “increased rescue capabilities have not increased survival,” as the advent of companion equipment such as transceivers and avalanche airbags along with improved companion rescue training has had a major impact on survival.¹⁷⁻¹⁹ Although we would agree that organized rescue is, by comparison, limited in success,¹⁶ we are not aware that increases in organized rescue performance have been demonstrated to have no impact, as this has not been systematically examined.

Dr Zafren’s “problem” with our recommendation, when manpower and other resources increase, to evacuate “more severely injured patients to an accredited Trauma Center”¹ where feasible overlooks our next sentence “due to transportation limitations, individuals may be transported to the nearest healthcare facility for stabilization and initial treatment.”¹ His statement that “trauma centers are often beyond the range of helicopter transport at all” is inaccurate for many if not the majority of avalanche incident locations and is awkward when followed with “in the case of apneic hypothermic patients, the most appropriate destination hospital may not

be a trauma center but should be a center capable of performing cardiopulmonary bypass.” Certainly, all hypothermic avalanche victims in cardiac arrest who are recovered with a core temperature of less than 32°C and a patent airway and without unsurvivable injuries should be transported for extracorporeal rewarming when feasible.^{13,15} In the majority of cases this transport will be, at least in part, by air.

We maintain that our proposed AvSORT algorithm is applicable for the “initial management of mass casualty avalanche accidents where manpower is overwhelmed.” We agree that future use of the tool should be examined critically, as with any proposed strategy. We could conclude by stating: “An asphyxiated unresponsive apneic bird in the hand is not worth 10 in the bush.” However, to misuse a simple proverb does not do justice to the complexity of a mass casualty incident nor the valiant efforts of brave rescuers making rational decisions.

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Physiological Demands of Hiking the Grand Canyon

To the Editor:

Hiking from top to bottom of the Grand Canyon National Park in Arizona has been a popular endeavor for many years. The most common hike starts at approximately 2100 m above sea level and follows the South Kaibab Trail to Phantom Ranch at the bottom of the canyon (732 m above sea level) and back. The length (~30 km), duration (6–9 hours), and inclination (~13%) of this journey exerts extraordinary strain on the hikers' physique, which is influenced by dietary intake, backpack weight, and environmental conditions. The ambient temperatures at the canyon vary widely throughout the year, exceeding 38°C (100.4°F) in the summer months and falling below –18°C (–0.4°F) during the winter.¹ To prevent the risk of dehydration, heat stroke, hyperthermia, and hypoglycemia, especially in unacclimatized and inexperienced hikers, the Park Service does not recommend completing this journey in 1 day, as evidenced by numerous warning signs.

The intent of this letter is to highlight potential areas of further research regarding the physiological responses to desert hiking and severe environmental conditions. To carefully estimate the cardiopulmonary and metabolic demands during hiking in such an environment, 1 male (age: 31 years, weight: 77.2 kg, height: 179.0 cm) volunteered for a trial, following 5 days of acclimatization to the altitude. The hiker's peak oxygen uptake ($\dot{V}O_{2\text{peak}}$) of 61.2 mL·min^{–1}·kg^{–1} and maximal heart rate (HR_{max}) of 191.0 bpm were measured during a treadmill ramp protocol (Woodway, Lörrach, Germany; starting at 12 km·h^{–1} and increasing 1°·min^{–1}) using a breath-by-breath analyzer (Metamax 3B, Leipzig, Germany) 10 days before the journey.

Accompanied by a research team, the volunteer hiker started from Yaki Point on the South Rim at 7:45 AM on March 21, 2009. The descent via the South Kaibab Trail lasted 3:15 hours and led to Phantom Ranch (~13% mean grade), the reversal point of the hike. The uphill hike followed the Bright Angel trail (~13% mean grade) and lasted approximately 4 hours. The volunteer was instructed to hike at a self-selected constant pace.

The ambient temperature during the day ranged from 15°C in the morning up to 29°C at 1:48 PM. The volunteer wore shorts and a light wind jacket during the first hour of the hike, thereafter he switched to shorts and T-shirt. Oxygen uptake ($\dot{V}O_2$), respiratory exchange ratio (RER), and heart rate (HR; Polar Belt, Kempele, Finland) were collected telemetrically throughout the entire hike (Metamax 3B). Based on these data, the active energy expenditure (AEE) of the participant was calcu-