

## Supplemental Oxygen and Mountaineer Death Rates on Everest and K2

To the Editor: The use of supplemental oxygen by Himalayan mountaineers has been debated for more than 8 decades.<sup>1</sup> Although sometimes viewed as unsporting, supplemental-oxygen use may improve survival rates by increasing performance and lowering hypoxic stress.<sup>1-3</sup> Analyses of death rates of mountaineers descending from high summits may reveal an impact of supplemental oxygen on survival because descending mountaineers are often near exhaustion and vulnerable to accident, storm, or illness during their descent.

**Methods.** We analyzed interview data<sup>4,6</sup> and more recent data (Elizabeth Hawley, oral communication, May 4, 2000) on all mountaineers reaching the summit of the 2 highest peaks (Everest and K2) from 1978 (year both summits first reached without supplemental oxygen) through 1999. For "summit-team" analyses on Everest, we excluded recent data (1993-1999) to reduce the impact of guided expeditions, which may include inexperienced climbers. We used exact logistic regression (conditional maximum likelihood) with survival as the dependent variable and supplemental oxygen (used and not used) as a factor, stratified by mountain (Everest and K2). In a preliminary analysis, the year of summiting (covariate) was unrelated to individual death rates on Everest (either directly or via an interaction with supplemental oxygen,  $P > .27$ ) and hence excluded from final analyses.

**Results.** Individual mountaineers not using supplemental oxygen had significantly higher death rates during descent than did those using supplemental oxygen (TABLE,  $P < .001$ ). This pattern is especially evident on K2, where approximately 1 in 5 climbers not using supplemental oxygen died during descent (Table).

To control for nonindependence of climbers in a team, we used a "summit team" as a complementary unit of analysis and determined (for each team reaching the summit on a given day and route) whether supplemental oxygen was used and whether any descending mountaineer died. Number of summiters was a covariate because the probability of a death(s) may increase with the number of climbers exposed to risk. Even by this conservative analysis, teams not using supplemental oxygen had relatively high death incidences ( $P = .03$ ).

**Comment.** Reaching the summit of Everest, and especially of K2, is dangerous. Overall, 1 in 29 climbers died during descent on Everest, and 1 in 7 died on K2 (Table). Reaching those summits without supplemental oxygen is associated with an even higher risk: 1 climber in 12 died on Everest, and approximately 1 in 5 died on K2 (Table). The survival impact of supplemental oxygen may be greater than suggested because mountaineers not using supplemental oxygen are probably relatively more experienced and therefore might be expected to have lower death rates. The association may be causal because supplemental oxygen decreases exposure time and reduces physical deterioration.<sup>1,3</sup> Nevertheless, alternative explanations (eg, mountaineers using supplemental oxygen are more risk averse) cannot

**Table.** Use of Supplemental Oxygen and Death Rates of Individual Mountaineers and for Summit Teams\* During Descent From the Summits of Everest and K2 Between 1978 and 1999

Mountain	Individual Mountaineers†		Summit Teams‡	
	Ascents, No.	Deaths, No. (%)	Teams Summiting, No.	Teams With Death, No. (%)
Everest				
Used supplementary oxygen	1077	32 (3.0)	93	8 (8.6)
No supplementary oxygen	96	8 (8.3)	28	4 (14.3)
K2				
Used supplementary oxygen	47	0 (0)	12	0 (0)
No supplementary oxygen	117	22 (18.8)	36	12 (33.3)

\*Summit-team analyses for Everest restricted to 1978-1992, see "Methods" section.

†For comparison by exact logistic regression, stratified by mountain,  $P < .001$ .

‡For comparison by exact logistic regression, stratified by mountain and with number of summiters per team as a covariate (included because the probability of a death should increase with the number of climbers exposed to risk, all else being equal),  $P = .03$ .

be excluded. Moreover, a full risk assessment of supplemental oxygen use awaits incorporation of data on death rates during ascent, risk to porters ferrying oxygen canisters, actual causes of death, and weather conditions. In any case, Himalayan mountaineering is a dangerous activity<sup>2</sup> that balances adventure against risk. Mountaineers considering whether to use supplemental oxygen should consider the risk of death during descent.

Raymond B. Huey, PhD  
University of Washington  
Seattle

Xavier Eguskitza  
Worcester, England

**Funding/Support:** This study was funded by a fellowship to Dr Huey from the J. S. Guggenheim Fellowship.

**Acknowledgment:** We thank T. Hornbein, MD, University of Washington, Seattle, and C. Houston, MD, University of Vermont, Burlington, for advice, and E. Hawley, Consul for New Zealand, Kathmandu, Nepal, for sharing data.

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## CORRECTION

**Incorrect Wording:** In the Original Contribution entitled "The Accuracy of Patient History, Wheezing, and Laryngeal Measurements in Diagnosing Obstructive Airway Disease" published in the April 12, 2000, issue of THE JOURNAL (2000;283:1853-1857), there was incorrect wording in the abstract. On page 1853, in the "Results" section, the sentence that read "maximum laryngeal height of at least 4 cm" should have read "maximum laryngeal height of 4 cm or less."