WILDERNESS ESSAY

Inheritors of Fate: Mountaineering, Science, and George Mallory's Legacy

George W. Rodway, PhD, APRN; Jeremy S. Windsor, MB, ChB

From the University of Utah College of Nursing and School of Medicine, Salt Lake City, UT (Dr Rodway); and Centre for Altitude, Space and Extreme Environment Medicine (CASE), University College London, UK (Dr Windsor).

George Leigh Mallory (Figure 1) and his partner Andrew “Sandy” Irvine disappeared high on Mt Everest during their push for the summit on June 8, 1924. Mallory’s adventurous spirit did not perish there, however; it continued to flourish in following generations. His children and other family members continued exploring mountains and the science behind climbing them. Thus, it is Mallory’s legacy we explore in this article.

Approximately 3 weeks before the June 8, 1924 disappearance, Mallory wrote a letter to his 8-year-old daughter. The letter, dated May 16, 1924, reads in part:

My dear Clare,

I am sitting in the big green tent which we call the Mess Tent; the sun is beating on it and there is not much wind today so it is nice and warm. . . . If I were to go outside the mess tent the first thing I should notice after our tents and the rows of wooden boxes which contain stores of all kinds would be the ravens, very big glossy black ones – quite a number of pairs live more or less permanently in our camp. . . . And of course I should look at the mountain; the mountain I need hardly say is Mount Everest; when I last looked it was smoking hard; that means to say that a puff of cloud was streaming away from the summit; the wind always comes from the right side of Everest as we look at him and we see the cloud trailing away on the left, and we can tell more or less by the shape of the cloud etc., how strong the wind is. Now this morning when I got out of bed and looked at the mountain I could see no cloud at all; and I believe there was no wind or practically none up there – certainly there was none down here – and when we see the mountain calm in the early morning then we think we may be able to get to the top.¹ (pp. 245–246)

While no one has yet discovered whether the top of Everest was reached by Mallory and Irvine during that fateful day in 1924, no convincing evidence exists that

either of them was sighted again until 1999. On May 1 that year, an Anglo-American expedition discovered Mallory’s body at an altitude of approximately 27 000 ft (8100 m). The team that “examined” him concluded from available evidence that he had died during or, more likely, shortly after a fall from which he had sustained several discernible injuries.

When the expedition that discovered the body produced a book several months after the find, Clare Millikan (née Leigh-Mallory) provided the book’s foreword. Seventy-five years after last seeing her father alive, and roughly a year and a half prior to her own death, she remarked:

The remarkable discovery of my father’s body this spring, which this book [*Ghosts of Everest*] chronicles, at first left me feeling very little beyond a mild annoyance that his resting place had been disturbed. It seemed to me that his spirit was far from his body. Gradually, though, as I actually spoke with the climbers who found him, as I experienced their reverence for this man and their sense of his being at peace with the mountain, an old feeling began to resurface: had he turned back earlier, he might have survived instead of lying there, broken on that cold ledge, and I would have grown up to know a wonderful man as my father.² (pp. 7–8)

However, regardless of the tragedy she suffered in losing a parent in one of the world’s highest, coldest, and most remote of places, the mountains and high-altitude environments were never far from her consciousness. Perhaps not surprisingly, quite similar interests were shared by her husband and children in later years.

After George’s disappearance on Everest, Ruth Mallory (George’s widow) took Clare and her siblings John and Berry to live with her father. Ruth is said by her son John to have made a conscious decision to bring up her children as free spirits, encouraging them to emulate their father’s love of adventure.¹ (p. 265) They also learned

Corresponding author: George W. Rodway, PhD, APRN, University of Utah College of Nursing and School of Medicine, 10 South 2000 East, Salt Lake City, UT 84112 (e-mail: gwrodway@hotmail.com).

Figure 1. George Leigh Mallory with the climbing team that was the first ever to break the 8000 m barrier (Mt Everest, 1922), and no supplementary oxygen was used in the process. A few days later, 2 other members of this expedition, G. Finch and G. Bruce, did use supplementary oxygen to climb a few hundred feet higher (~100 m) than Mallory's party. Left to right: Henry Morshead, George Mallory, Howard Somervell, and Edward Norton. Mt Everest Basecamp, Rongbuk Glacier, Tibet. Image reproduced with permission of Anne Russell.

to climb, most notably in Snowdonia, where they would stay at their father's old haunt at Pen y Pass. Clare and Berry became serious enough about climbing that they took part in the ascent of a new route on Clogwyn du'r Arddu (on the north flank of Snowdon), one of Great Britain's most hallowed cliffs. In a June 2010 discussion with one of the authors of this article (Rodway), Anne Russell, daughter of early Everest George Ingle Finch and one of Clare's female climbing companions, stated that Clare was responsible for getting her interested in doing hard climbs at a time when serious female climbers were few and far between. Anne particularly recalled the Easter climbing parties held by Geoffrey Winthrop Young at Pen y Pass (notably the 1937 and 1938 events) as being the setting where Clare encouraged her to exploit her native talents and take her climbing adventures to the next level. Clare eventually climbed farther afield, as well, in England's Lake District and then in the Alps.

In August of 1938, Clare married Glenn A. Millikan, a lecturer in physiology at Trinity College in Cambridge (UK), whom she had met during her student days at the university. Glenn, born in 1906 in Chicago, was the second son of Robert A. Millikan, the eminent physicist, who was the first to successfully measure the charge of an electron. For this, he was subsequently awarded the 1923 Nobel Prize in Physics. Glenn entered Harvard in 1923 and, after graduation in 1927, spent a year in Germany. He then went to work with the distinguished physiologist Joseph Barcroft in Cambridge, where he obtained his doctorate. He subsequently became a lec-

turer in physiology at Cambridge, where he continued his interest in tissue oxidation.

At Cambridge in the early 1930s, Millikan worked to find an optical means of measuring color change in hemoglobin in conjunction with his research in myoglobin-oxygen reactions. As a result of his efforts, he was able to design and construct a dual wavelength photoelectric colorimeter to measure blood oxygen saturation.³ With this device Millikan and colleagues studied the reactions that occurred between hemoglobin and various gases. This was the precursor to an apparatus that Millikan conceived several years later during the early days of World War II—a lightweight and practical aviation ear oxygen meter for which he coined the term “oximeter” (Figure 2). Since then, the (pulse) oximeter has transformed the measurement of arterial blood oxygen saturation into a reliable, objective, and noninvasive monitor. Over the years, the signal processing of these contrivances has significantly improved and has thus made modern pulse oximeters quite reliable even under adverse measurement conditions.

In 1939, the year after Clare Mallory and Glenn Millikan were married in Godalming, England, they traveled to California to visit Millikan's parents. While there, war broke out in Europe. As prospects were looking bleak for Great Britain in the early days of the war, Millikan's mentors at Cambridge advised that the couple remain in the USA. Millikan was fortunately able to continue with his research when a position was offered at the Johnson

Figure 2. Millikan oximeter earpiece in position on an ear.

Foundation of the University of Pennsylvania. By 1940, a physiology professor from Cambridge by the name of Lord Adrian was in contact with Millikan about war-related work. Adrian had become deeply involved in the British scientific war effort associated with aviation physiology, and related to Millikan the problems aviators were experiencing with loss of consciousness during dogfights at high altitude. Millikan was asked to help in the development of an oxygen delivery system with a demand valve that would respond to changes in altitude and individual oxygen requirements. For the duration of the war, Millikan and colleagues concentrated their labors on oximetry together with a number of other areas relevant to aerial combat at high altitude—oxygen demand valves, chemical oxygen generators, carbon monoxide poisoning, and pressure breathing.⁴

Millikan and his associates developed a working oximeter very early on in the course of the war and arranged to have it commercially produced. According to Clare, with the help of the Bendix Corporation, Millikan and coworkers constructed a servo-type system that would allow the oxygen supply to an aviator's mask to be controlled by oxygen saturation of the blood (as measured with an oximeter). There was, somewhat surprisingly, very little initial US government interest in this device. Only when the US military discovered that the *Luftwaffe* (German air force) already had such a piece of equipment did the American government begin to pursue this line of research and development.⁴ With regard to oxygen equipment and most other aviation-related paraphernalia and knowhow, Germany initially had a vast lead over the English-speaking countries. As the war progressed, however, Germany became stressed to the breaking point, and they struggled to maintain pace with the rapid technological and scientific developments coming out of the Allied countries.

Development of the chemical oxygen-generating (Chemox) system by Millikan and coworkers occurred during the latter years of the war, when both allied and axis powers were endeavoring to produce a practical apparatus for chemically generating oxygen in aircraft. This was, in turn, the basis for the supplementary oxygen system used during the Swiss attempt on Mt Everest in the spring of 1952.⁵ This attempt, which was the first serious summit attempt from the south (Nepal) side, unfortunately became hampered by this oxygen-generating system. The equipment had been designed as emergency supply oxygen in aircraft, and later saw use in the service of mine rescue, but had a major limitation for use when climbing at extreme altitude: it could only be effectively used at rest. The inspiratory and expiratory resistances of the device were excessively high for the levels of ventilation required during exercise at greater than 8000 m. Another factor rendering the equipment useless during climbing was that the apparatus was

provided with a rigid plastic mouthpiece that did not allow the head to be moved about when in the mouth. The Swiss accepted the oxygen-generating equipment knowing these faults, thinking the use of supplementary oxygen at rest would be of value to the climbers. However, it seems they had bad advice on the matter. It was known by 1952 that breathing oxygen during *active* climbing at extreme altitude would improve performance. However, as far back as 1920, Alexander Kellas had accurately (and convincingly) shown that inhaling oxygen at rest would not enhance a climber's subsequent period of ascent at high altitude. Given that the human body can "store" only very small quantities of oxygen in the tissues, anything inhaled strictly at rest would "wash out" within moments of resuming ascent. It is notable that the Swiss returned in the autumn of 1952 for a second attempt at Everest—this time with an improved method for delivering supplemental oxygen. However, the weather was very uncooperative, and they were not even able to reach the high point of their spring expedition.

It is an interesting twist of fate that George Mallory's son-in-law was responsible for the design of the oxygen equipment used by an Everest expedition nearly 30 years after Mallory's disappearance on the mountain. However, the story of the Mallory-Millikan connection to mountain exploit does not end here. Shortly after the end of World War II, Millikan was given the opportunity to return to the UK and a similar position to his prewar post in Cambridge. Instead he decided to accept an offer from the Physiology Department at the Vanderbilt (Nashville, TN) School of Medicine. In 1947, while climbing with Clare and several friends in the Cumberland Mountains of eastern Tennessee, Glenn Millikan was struck in the head by a large rock dislodged by the climbing rope. He died almost immediately. In a chilling replay of her mother's life, Clare was left to raise three small children (all boys in this case) by herself. In an interview published on June 12, 1999 in the *Los Angeles Times*,⁶ it was related that:

... the only consolation was that, coming home, she knew what to say to her children. She had heard it from her own mother [in 1924]. "Your father is dead, and he will never come back."

Although Ruth Mallory had encouraged her children to have their own mountain adventures after George's death, Clare supported even grander alpine exploits in her boys after Glenn's demise. In the early 1950s, she took her 3 adolescent sons off to the Sierra Nevada range in California to teach them to rock climb.⁷ (p. 67) Of the 3, George and (especially) Rick developed a most ambitious interest in climbing. David Roberts, a well-known author of many mountaineering and other non-

fiction works, first made the acquaintance of George and Rick at Harvard when all were students there during the early 1960s. Perhaps not surprisingly, they met through the university's renowned mountaineering club. Roberts later wrote:

Though it would be years before I dared talked to Rick about these matters [surrounding his father's and grandfather's death], I was deeply impressed that [first] autumn to discover that a family that had suffered such losses in the mountains should produce so blithe and ambitious climber as Rick.⁷ (p. 67)

Roberts reflected on Clare's attitude toward her son's climbing activities, finding it remarkable that despite the twin tragedies in her life, Clare had not only tolerated her sons' embrace of this most dangerous sport—she had taught them to climb and heartily encouraged their alpine play.⁸ (p. 13)

That George Leigh Mallory's unique approach to life survived in his descendants long after his death probably comes as little surprise to most of us. However, in a larger sense, his legacy has touched and motivated countless others aspiring to great things regardless of their own personal Everests, be they the physical and spiritual

feats Mallory himself performed, or achievements of a more analytical nature reminiscent of Mallory's son-in-law, Glenn Millikan.

References

1. Gillman P, Gillman L. *The Wildest Dream: The Biography of George Mallory*. Seattle: The Mountaineers Books. 2000.
2. Hemmleb J, Johnson LA, Simonson ER. *Ghosts of Everest: The Search for Mallory and Irvine*. Seattle: The Mountaineers Books; 1999:7–8.
3. Millikan GA. A simple photoelectric colorimeter. *J Physiol*. 1933;79:152–157.
4. Severinghaus JW, Astrup PB. History of blood gas analysis. VI. Oximetry. *J Clin Monit*. 1986;2:270–288.
5. West JB. Failure on Everest: the oxygen equipment of the spring 1952 Swiss expedition. *High Alt Med Biol*. 2003;4:39–43.
6. Murphy K. Dealing with artifacts of Everest climber Mallory poses new challenge. *Los Angeles Times*. June 12, 1999. Available at: <http://articles.latimes.com/1999/jun/12/news/mn-45714>.
7. Roberts D. *On the Ridge Between Life and Death: A Climbing Life Reexamined*. New York: Simon & Schuster; 2005:67.
8. Anker C, Roberts D. *The Lost Explorer: Finding Mallory on Mount Everest*. New York: Simon & Schuster; 1999:13.