Chapter 1

A TRIBUTE TO JOHN BURNARD WEST

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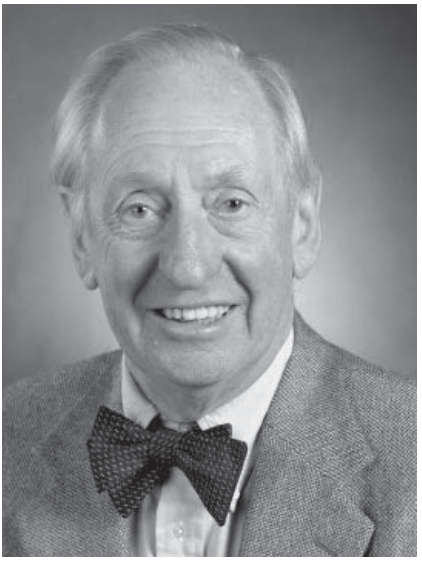

Abstract: John West is well known to the "Hypoxia" community for his many contributions to the physiology and Pathophysiology of high altitude and for his leadership of the 1981 American Medical Research Expedition to Everest. He is known to the wider medical world for his researches into respiratory physiology especially gas exchange in the lung and perhaps even more for his numerous books on these topics. His publication list numbers over 400 original papers. His research career started in the UK but since 1969 he has been Professor of Medicine at UCSD, leading a very productive team at La Jolla. He has been honoured by numerous prizes and named lectureships, the latest honour being to be elected to the Institute of Medicine, National Academies (USA).

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INTRODUCTION

It is entirely fitting that this year when he has recently been honoured by being elected a Member of the Institute of Medicine, National Academies, the Symposium organisers should select John West to be the scientist who we are honouring. I am pleased to be asked to compose this tribute but if it is not as fulsome and laudatory in tone as some previous ones, I ask John's indulgence and plead the twin handicaps of the British love of understatement and an old friend's licence to tell it as he sees it!

I have known John West as a friend, expedition companion and scientific colleague for about 45 years. We first met in 1960 when preparing for the 1960-61 Himalayan Scientific and Mountaineering Expedition, popularly known as the Silver Hut Expedition. I was, even then, aware of his reputation as a bright young medical researcher at the Postgraduate Medical School, Hammersmith Hospital where he had done work on lung gas transfer, exploiting the unique opportunity afforded by the MRC cyclotron sited there.

Since then our paths have crossed and re-crossed. He invited me on his American Medical Research Expedition to Everest (AMREE) in 1981, and we were together on a trek in Sikkim in 2000. From 1985 to the present we have worked as joint authors, with Michael Ward, on the textbook "High Altitude Medicine and Physiology" as well as frequent meetings at conferences and social occasions.

John is a man of many parts, researcher, teacher, author, editor, and organiser/administrator. His interests also include music, ham radio, radio-controlled gliders, tennis, skiing, mountaineering and of course he is a family man.

In this short tribute I can only give the reader a flavour of the man and a few personal reminiscences. No doubt there will, in time, be a full biography of John B. West!

The Researcher

John West is probably best known to the Hypoxia community for his research work in the field of high altitude medicine and physiology. His interest in the effects of altitude hypoxia followed naturally from his early work on pulmonary gas exchange which started when he was a junior doctor at the Postgraduate Medical School. The MRC cyclotron could produce short-lived radio-isotopes of oxygen. The oxygen-15 could be inhaled or infused either as O_2 or CO_2 and the activity counted over the chest wall. This resulted in a number of important papers in 1960. The one I remember reading at the time I first met John was in the *BMJ*. There was also one in *J. Appl. Physiol.* in the same year. This was the time when I was working with Dr Griffith Pugh (honoured at Hypoxia 1993) preparing for the Silver Hut Expedition of which he was the Scientific Leader. John had also been invited to be a member and we met doing base line exercise experiments at Griff's MRC lab in Hampstead and again in Oxford for control of breathing studies, my particular responsibility (Figure 2).

The work John did on the Silver Hut was again on gas exchange. He measured the diffusing capacity of the lung for carbon monoxide and showed there to be no change with acclimatization, apart from the small effect of increased haemoglobin concentration. He

was also involved, as we all were, in the exercise studies and with Mike Ward measured $\dot{V}O_2$ max on the Makalu Col (7440m), still, 44 years later, the highest altitude at which it has been measured! (Figure 3) The reduction in $\dot{V}O_2$ max with altitude, he showed, was largely due to diffusion limitation, again a matter of gas exchange.

Figure 2. John West as subject of a control of breathing experiment inside the Silver Hut, 1961.

Figure 3. John West and Michael Ward setting up the bicycle ergometer on the Makalu Col, (7440m) to measure $\dot{V}O_2$max on themselves.

After the Silver Hut, he did a post-doc fellowship with Herman Rhan (an Honouree at Hypoxia 1991) in Buffalo and then became leader of a MRC Respiratory Physiology Group at the Hammersmith studying pulmonary gas exchange. He had a sabbatical year 1967-8 with NASA at the Ames Research Center. Here he has the opportunity to work on computer models of gas exchange. He put in his first research proposal to NASA on lung function in astronauts at the end of this year and since then has had a continuing connection with space research on the effect of micro-gravity on gas exchange.

In 1969 John joined the faculty of University of California, San Diego where he is still working as Professor of Medicine. On arrival, his NASA project was approved and a check for $100,000 started his career in La Jolla on the right foot! Work on computer modelling of gas exchange led, in collaboration with Peter Wagner, to the multiple inert gas method for measuring V/Q ratio inequalities in health and disease. His more recent research includes work on stress failure of the alveolar-capillary wall as part of the mechanism of high altitude pulmonary edema and the use of oxygen enrichment of room air in high altitude living quarters.

Publications

John's bibliography is impressive and can be found on the web at: http://medicine.ucsd.edu/faculty/west/.

He has published 424 papers, in 290 of which he is the first author (68.4%). The great majority of these have been in prestigious peer reviewed journals. By today's standards he was a late starter. His first paper, on ventilation-perfusion ratio inequality in the lung by single breath analysis, was in *Clinical Science* in 1957 when he was 28 and had been qualified for 6 years. However once John got started, he was soon churning out significant papers in respectable numbers as shown in Fig 4.

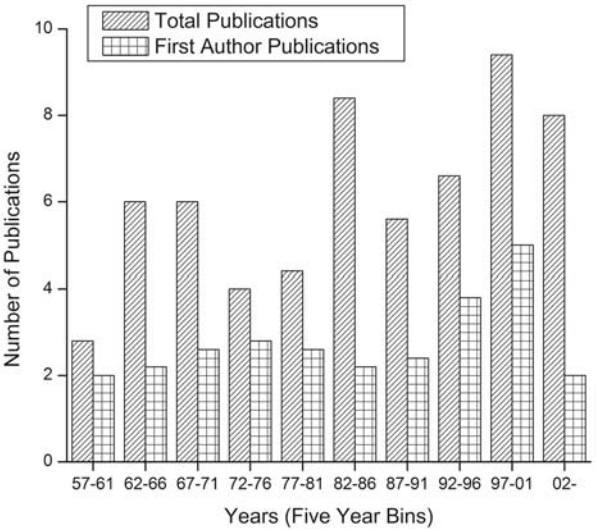

Figure 4. Papers published by John West, average number per year in 5 year bins, showing 1st author and totals.

As impressive as the numbers and quality of his papers, is the fact that with the passing years his output, far from diminishing, has actually increased! There is a significant linear increase in numbers of paper with each quinquennium of his career ($p=0.015$). If the trend continues, I can confidently predict, that on reaching his centenary, he will be publishing at the rate of 16.5 papers per year!

The Teacher

I cannot report on John's ability as a teacher in medical school though I am sure his courses are very well appreciated. As a lecturer I have heard him on numerous occasions and can vouch for his ability to give a clear and exciting account of even the most difficult of subjects such as *V/Q ratio inequalities*. His lecture on AMREE and Peter Hackett's solo summit climb is exciting in both scientific and mountaineering content and style. Evidence of the widespread appreciation of his abilities as a lecturer is the number of prestigious named lecturers he has been asked to give: 57 at the last count, mostly in the USA but also in UK, Canada, Australia and Russia.

However, I think that his most important role as a teacher is as author of numerous textbooks and monographs. These have made him well known to the wider medical world. John has 21 books on his publications list; in some, he is the editor of multi-author books or conference proceedings but in the majority he is sole author. The titles range from *Ventilation/Blood flow and Gas Exchange,* his first monograph, through *The Use of Radioactive Materials in the Study of Lung Function; Translations in Respiratory Physiology*, his first assay into the history of our subject, to *Gravity and the Lung: Lessons from Microgravity,* his latest book. For the Hypoxia community, John's excellent history of our subject, *High Life,* and our joint book *High Altitude Medicine and Physiology* are, no doubt the best known. However, John's most influential book is probably *Respiratory Physiology - The Essentials* followed by *Pulmonary Pathophysiology - The Essentials*. The former was originally written for Medical Students and both are required reading for many postgraduate courses. Both books have been translated into many languages and have gone into 7 and 6 editions in English, respectively. Mention John West's name to any young anaesthetic trainee and (s)he is likely to respond, "Not *The* John West of *Respiratory Physiology*!"

Also important in the wider teaching role of promoting scientific communication, is John's work in the thankless task of editorship. He showed early promise of this by starting a journal whilst still a school boy at Prince Alfred College in Adelaide. The PAC Science Journal is still being published 60 years later! John is on the editorial board of 17 learned journals and of course is the Editor-in-chief and founder of our own, very successful journal, *High Altitude Medicine and Biology.* We all hope his latest journal proves to be as long lived as his first!

The Man

He chose to head up quite a small division of physiology at La Jolla rather than build up a big empire but his organisational abilities are considerable. Anyone who can put together an Everest Expedition, especially one that carries through both scientific and mountaineering objectives as he did with AMREE has to have such skills in spades! He has received numerous honours including being elected President of the American Physiological Society and the International Society of Mountain Medicine. His most recent honour, last year, is to have been elected to the Institute of Medicine of the National Academy of Sciences (USA)!

I personally owe John a lot, in that he was one of three or four men who influenced me in becoming interested in academic medicine and specifically respiratory physiology. We had many long discussions whilst trekking on the Silver Hut Expedition or sharing a tent in the Western Cwm on AMREE. One of the earliest of these I remember was his unfolding to me the beauties of the Rhan/Otis O_2/CO_2 diagram! Happy days!

John never claimed to be a climber but he has a love of mountains and enjoys trekking and skiing. The pinnacle of his mountaineering was probably, at the end of the Silver Hut Expedition. He made a solo ascent to the Makalu Col and organised the rescue of the near dead climber, Pete Mulgrew, from the Col when other members of the team were exhausted and devoid of drive.

John has been fortunate in having a wonderfully supportive wife in Penny and two children to be proud of in Joanna and Robert.

SELECTED REFERENCES OF JOHN B. WEST

Books

1. West, J.B. Respiratory Physiology - The Essentials. 7th edition. Philadelphia: Lippincott Williams & Wilkins, 2005.
2. West, J.B. Everest - The Testing Place. New York: McGraw-Hill, 1985.
3. West, J.B. High Life: A History of High-Altitude Physiology and Medicine. New York: Oxford University Press, 1998.

Articles

1. West, J.B. and C.T. Dollery. Distribution of blood flow and ventilation-perfusion ratio in the lung, measured with radioactive CO2. *J. Appl. Physiol*. 15: 405-410, 1960.
2. West, J.B. Diffusing capacity of the lung for carbon monoxide at high altitude. *J. Appl. Physiol.* 17: 421-426, 1962.
3. Pugh, L.G.C.E., M.B. Gill, S. Lahiri, J.S. Milledge, M.P. Ward, and J.B. West. Muscular exercise at great altitudes. *J. Appl. Physiol*. 19: 431-440, 1964.
4. West, J.B., C.T. Dollery and A. Naimark. Distribution of blood flow in isolated lung; relation to vascular and alveolar pressures. *J. Appl. Physiol.* 19: 713-724, 1964.
5. West, J.B. Ventilation-perfusion inequality and overall gas exchange in computer models of the lung. *Resp. Physiol*. 7: 88-110, 1969.
6. Wagner, P.D., H.A. Saltzman and J.B. West. Measurement of continuous distributions of ventilation-perfusion ratios: theory. *J. Appl. Physiol.* 36: 588-599, 1974.
7. West, J.B. and P.D. Wagner. Predicted gas exchange on the summit of Mt. Everest. Resp. Physiol. 42: 1-16, 1980.
8. West, J.B., P.H. Hackett, K.H. Maret, J.S. Milledge, R.M. Peters, Jr., C.J. Pizzo and R.M. Winslow. Pulmonary gas exchange on the summit of Mt. Everest. *J. Appl. Physiol*.: Resp. Environ. Exercise Physiol. 55: 678-687, 1983.
9. West, J.B., S.J. Boyer, D.J. Graber, P.H. Hackett, K.H. Maret, J.S. Milledge, R.M. Peters, Jr., C.J. Pizzo, M. Samaja, F.H. Sarnquist, R.B. Schoene and R.M. Winslow. Maximal exercise at extreme altitudes on Mount Everest. *J. Appl. Physiol*.: Resp. Environ. Exercise Physiol. 55: 688-698, 1983.
10. Winslow, R.M., M. Samaja and J.B. West. Red cell function at extreme altitude on Mount Everest. *J. Appl. Physiol*.: Resp. Environ. Exercise Physiol. 56: 109-116, 1984.
11. West, J.B. Human physiology at extreme altitudes on Mount Everest. *Science* 223: 784-788, 1984.
12. West, J.B. Highest inhabitants in the world. *Nature* 324: 5l7, 1986.
13. West, J.B., K. Tsukimoto, O. Mathieu-Costello and R. Prediletto. Stress failure in pulmonary capillaries. *J. Appl. Physiol.* 70: 1731-1742, 1991.
14. Prisk, G.K., H.J.B. Guy, A.R. Elliott, R.A. Deutschman III and J.B. West. Pulmonary diffusing capacity, capillary blood volume and cardiac output during sustained microgravity. *J. Appl. Physiol.* 75: 15-26, 1993.
15. West, J.B., O. Mathieu-Costello, J.H. Jones, E.K. Birks, R.B. Logemann, J.R. Pascoe and W.S. Tyler. Stress failure of pulmonary capillaries in racehorses with exercise-induced pulmonary hemorrhage. J. Appl. Physiol. 75: 1097-1109, 1993.
16. West, J.B. Oxygen enrichment of room air to relieve the hypoxia of high altitude. *Resp. Physiol.* 99: 225-232, 1995.
17. West, J.B. Snorkel breathing in the elephant explains the unique anatomy of its pleura. *Resp. Physiol.* 126: 1-8, 2001.
18. West, J.B. Thoughts on the pulmonary blood-gas barrier. *Am. J. Physiol.*: Lung Cell. Mol. Physiol. 285: L501-L513, 2003.