Building a library of engagement and teaching material based on 'real life' physiological data to enhance learning

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Introduction

Students studying stage 1 Biomedical Sciences subjects feed back that seminars are often not very engaging and that use of real data examples would be more interesting to them. When a member of staff said that she was trekking to Everest Base Camp in April 2019, the opportunity was seized to collect real life physiological data from her and her friends, intending to use this to produce engaging teaching materials for physiology seminars and outreach activities. The aims of this project were:

1. To design material for use in two stage 1 physiology seminars, using the real-life cardiovascular and respiratory data collected from trekkers ascending to altitude of ~5300m
2. To develop resources summarising key information on physiological changes in hypoxia (low oxygen in inspired air)

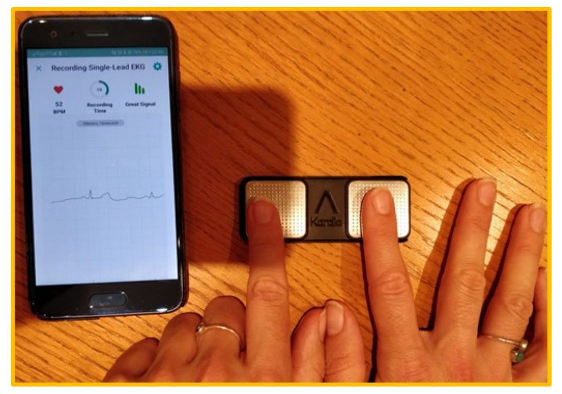

Figure 1. Using the portable ECG device with mobile app (Kardia).

Figure 2. Finger pulse oximeter.

Methods

- Real life data, collected on the trek daily by up to 10 trekkers and Sherpas, involved measurements of:

  - Heart Rate, using a portable ECG (electrocardiogram; recording heart rhythm) device (Figure 1)

  - O_2 saturation levels (% oxygen in blood) using a portable finger pulse oximeter (Figure 2)
- Research on the topic of altitude and the physiological changes in hypoxic environments, in order to be able to correctly interpret the data collected
- Research on the history of climbing Mount Everest to match significant physiological research with notable expeditions.

Results

Figure 3 shows the cardiovascular seminar designed. Some real life data is included to improve student awareness of experimental design and analysis. Questions relate to the results which, if correctly analysed should reveal an abnormality in the ECG, something that should be of interest to students. A respiratory seminar was also designed using the oxygen saturation data.

High Altitude: Cardiovascular Physiology

Below is an ECG recording taken from Dr Beth Lawry on her trek up to Everest Base Camp in April 2019. It was recorded in the morning before trekking at an altitude of 3,440m in a place called Namche Bazar. Dr Lawry noted that she had difficulty sleeping the night before this ECG was taken but was eating and drinking perfectly well.

In groups, discuss the following questions:

1. Pick out a 'normal' cardiac cycle from this ECG trace. Identify the P wave, QRS complex and T wave.
2. Measure the R-R interval between the 4^{th} + 5^{th} cardiac cycles. What does this tell us about the heart rate?
3. Can you notice anything abnormal about the ECG trace and/or the heart rate?
4. At rest, what nervous system mechanism has the main influence over heart rate control?
5. Dr Lawry had trouble sleeping: looking at the ECG trace and your HR analysis, why do you think that was? Can you come up with any ideas that explain the different waves and heart rates at altitude?

Figure 3. Cardiovascular physiology seminar material, based on data collected from one trekker.

Posters were created to:

- Describe specific changes in the respiratory and cardiovascular systems, summarising effects of acute (short term) exposure to low oxygen, pathophysiological effects and the process of acclimatisation. Figure 4 is the poster for respiratory changes, including the data illustrating changes in O_2 saturation with altitude, in trekkers and Sherpas.
- Outline physiological changes and health risks associated with ascending to the summit of Mount Everest (due to low atmospheric oxygen).
- Summarise timelines of physiological research developments and notable expeditions to Mount Everest, and indicating the clinical relevance of the research in treatment of diseases such as cancer, heart disease and cystic fibrosis.

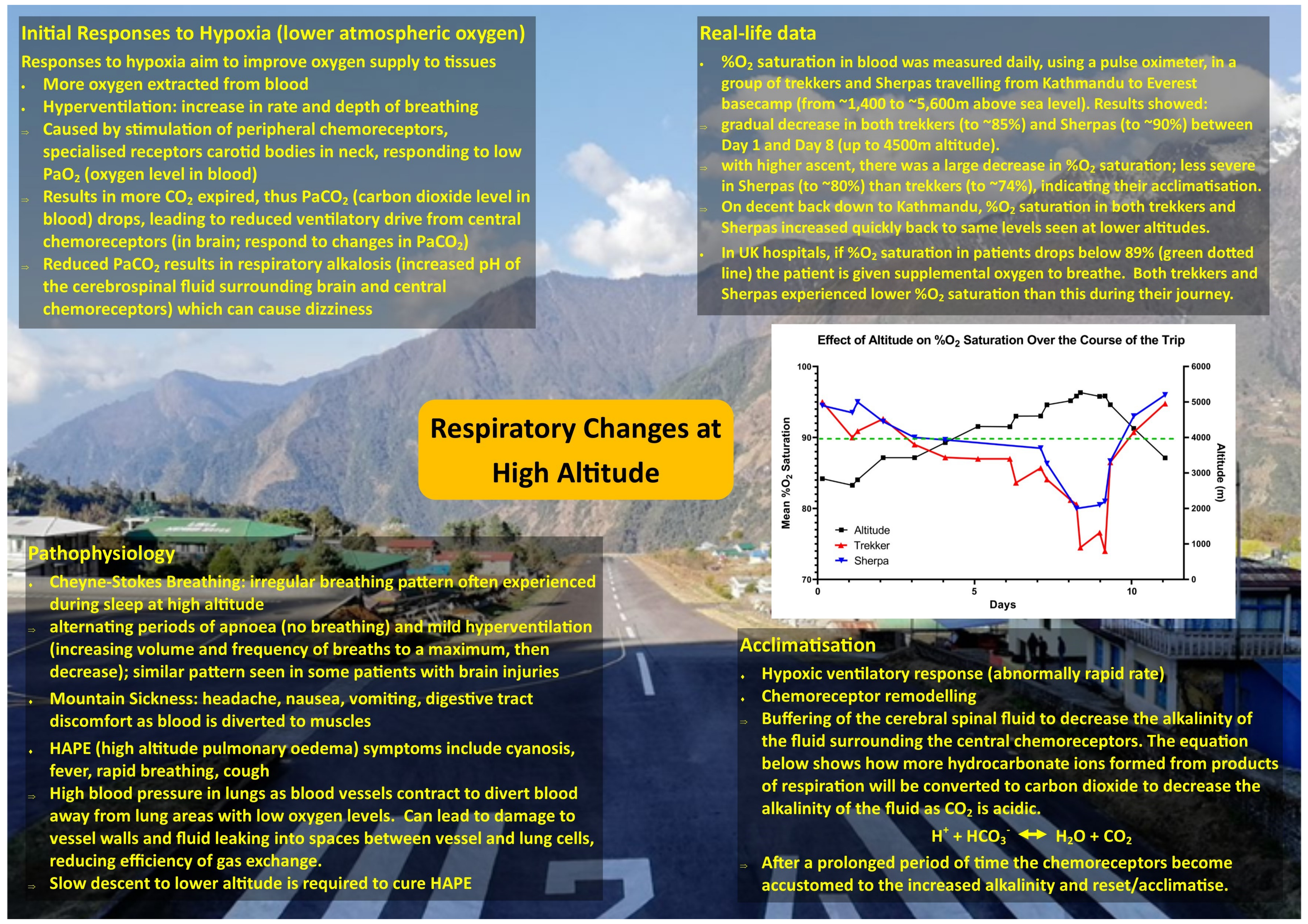

Figure 4. Poster summarising respiratory changes at high altitude. Graph shows that the reduction in O_2 saturation with increasing altitude is more profound in trekkers than in Sherpas.

Conclusions

The posters were used very successfully to engage and educate people about physiology at altitude during a recent Physiology Friday public engagement event. Many people were attracted to our stand by the images used and their interest in climbing.

The seminar material will be trialled with stage 2 students to gain feedback and optimise the content before they are used for teaching next semester.

Acknowledgments:

Sarah Cudworth for her data analysis and making the graphs for the posters (Figure 4).