



The ups and downs of overseas research – the inner ear at altitude

BY ANKIT PATEL

Conducting research at extreme altitude presents unique challenges. This study of the inner ear at 5350m navigates setbacks in a quest for scientific discovery.

Having completed a diploma in mountain medicine in my foundation years, I decided to undertake a research project and complete the masters. I had an extremely inspiring conversation with Miss Emma Stapleton and I decided to undertake a study to assess the inner ear at altitude. Miss Stapleton had completed a project in the Everest Region in 2008. Her preliminary data showed a degree of hearing loss and imbalance occurred at altitude. The pattern of low-frequency hearing loss had similarities to Ménière’s disease. We aimed to repeat a number of hearing tests to corroborate her findings and investigate it further using electrocochleography. It sounded very ambitious, but I love a challenge, and the idea of conducting research in the mountains was very exciting. I quickly wrote a research proposal which attracted a lot of interest.

The process of completing this project has produced a number of ups and downs, which I have been invited to share. In retrospect, I must say that the number of ‘downs’ seems to far outweigh the ‘ups’. Seeing the project from the idea to fruition required a number of steps, each presenting its own hurdles, which I have outlined in this article.

Applying for funding

This project would not be possible without external funding and assistance. I couldn’t anticipate all the costs in the preliminary stages, but the more funding I received, the better; I applied to as many sources as possible. This involved formal applications via research grants and contacting companies we regularly work with for assistance. There were several rejections but I eventually received

enough money from the William Demant Foundation, ENT UK, BSO and Minim Healthcare to make it reality. There is no doubt, receiving an email of a successful application is a definite ‘up’ in the process.

Ethics

I completed ethical approval via the University of Central Lancashire, where the masters was based. They had a strict process, which eventually went to an ethical committee. After several rounds and amendments, it is a very satisfying feeling to finally receive the approval. The process involves writing a sound research proposal with a clear methodology. An emphasis is placed on producing clear patient information leaflets and consent forms for the volunteers.

Making it happen

The actual process of making it a reality was a stormy one. We aimed to recruit eight healthy volunteers that were already travelling to an area of altitude. I would join this tour and look to recruit them into the study. An ethical requirement was for them to be UK residents. After toying with the idea of going back to the Everest Region, Kilimanjaro or South America, I eventually decided to go to Ladakh in Northern India – the location of the world’s highest road pass, the Khardung La, at 5350m. This is a common place for tourists, and the road access means carrying equipment is simpler.

Sourcing equipment was the next challenge. I needed to find a way of doing pure-tone audiometry, tympanometry, otoacoustic emission testing, electrocochleography and posturography in an extreme setting. Table 1 shows the methods I eventually used to produce these results.

Table 1: The methods employed to run various tests on the world's highest road pass, the Khardung La, in India.

Pure-tone audiometry	Using two different validated mobile app-based audiometry tests (AudCal & Hearing Test Pro) with over-the-ear headphones. Background noise checked at each point to confirm < 35 dB.
Tympanometry	Borrowed a portable tympanometer from a friendly audiologist.
OAEs	Using Interacoustics Eclipse machine.
Electrocochleography	Using Interacoustics Eclipse machine.
Posturography	Using three validated techniques: (1) RombergLab – using a Nintendo Wii board to assess balance in three conditions. (2) A motion sensor placed on the lumbar spine to assess balance in six conditions, including using a foam mat. (3) MCTSIB – posturography test.
BP/Saturations	Borrowed equipment from local pharmacy.
Questionnaires	Printed



Sourcing and training on every piece of equipment was challenging, but by far the most challenging was the machine to undertake electrocochleography. Normally, electrocochleography is performed in controlled quiet environments, so whether it was even possible at altitude was in doubt. Building a strong relationship with the audiology department was essential. I was fortunate to receive invaluable support and guidance from Mark Chung and Kajal Ramdan, who were exceptional throughout the project. Understandably, my request to borrow their newest electrocochleography machine was declined (called the Interacoustics Eclipse which costs in the region of 25k). However, they managed to source me a decommissioned but working module. It just required repairing and calibrating – luckily funding helped towards this.

One of the major challenges I anticipated was power in the mountains. I aimed to perform the testing in sequence from sea-level, to Leh (3500m), to Pangong Lake (4220m) and the Khardung La Pass (5350m). At Pangong Lake and the pass, there is little or no power available. Some of our equipment used mains power and there are limits to the amount of lithium batteries that can be taken as baggage on airlines. Needless to say, some of my lithium batteries were confiscated, despite being below the allowed amount. In the end, the only way I could produce 230V AC power to the Eclipse machine was to purchase 12V car batteries in Leh (easily available) and take a 12V to 230V inverter on the trip.

Challenges on the trip – when it all falls apart

I had some early wins: I managed to recruit seven volunteers into my study, one short of the aim, but I was willing to accept that. I successfully completed all the testing at sea-level (including dewaxing) and Leh at 3500m. It did take me five hours, even though I tried to find a system to test seven individuals as efficiently as possible.

When I got to Pangong Lake, the power issues were real. They had limited power available via a petrol generator for one hour of the day. But, I didn't fret, as I had my car batteries and inverter at the ready. As planned, I was able to produce 230V AC power from my inverter and the Eclipse turned on without a problem. However, unfortunately the inverter produced a level of electrical interference that, despite hours of my best attempts, I was unable to mitigate. The electrocochleography waveforms test the inner ear and require a very stable environment. For reasons beyond my understanding, the inverter produced a frequency of energy which prevented the machine from detecting the desired Ecog waveforms, although thankfully it was still able to produce OAEs. This was a huge disappointment. However, I knew time was precious so I focused on getting all the hearing and balance tests completed instead. I had results from sea-level and 3500m, on which I would have to base my conclusions.

I also had to remain tactful with my participants, who were volunteers in an extreme environment. The saturations were regularly in their 70s, and one participant had a saturation of 55% at one point. They could have easily become fed-up and pulled out of the project. I had to keep this in mind during the testing, and avoid endless repeats. In the end, I was incredibly fortunate to have amazing participants who completed the whole project.

Analysis and write-up

On my flight home, I must admit to feeling a huge sense of relief. The pressure of making the trip a reality and navigating the huge numbers of challenges had taken its toll. In the end, not everything went to plan, but I am content that I made the best of the situation. I will get to analysing the data in the coming weeks and the results will be disseminated in due course.

In summary, I'm not sure I would ever consider doing such a project again, but I have absolutely no regrets about embarking on this journey. I learned about audiology testing, ethics, funding and thinking outside the box to push a project over the line. The details of the testing and the challenges I faced are far beyond the scope of this article, so please feel free to contact me with any questions.

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