BIOREME Project – Public Involvement Activity: An immersive Virtual Reality lung journey

Background

BIOREME is a collaborative research network based at The University of Nottingham, with partners across the UK, including Imperial College London, and internationally. The network aims to bring together researchers, industry, charitable organisations and patients to identify key research challenges and ways to address them. The focus of the network is to apply mathematics to better understand, diagnose and treat lung diseases. This work is closely linked with our Respiratory Theme research projects.

The Imperial Patient Experience Research Centre (PERC) is a core facility of the National Institute for Health and Care Research (NIHR) Imperial Biomedical Research Centre (BRC) undertaking both research on research and supporting Imperial BRC researchers to undertake public involvement and engagement in research.

VR Project

The network's VR project is about the development of innovative lung game where players are immersed into an environment that represents the lungs and travel through them. The aim of the project is to be used as a public engagement activity in science festivals to allow participants explore how the airways of the lungs work and how diseases can affect their functionality.

In the game, players control a character on a mission to clear blocked airways in the lungs using the correct medications. The character is miniaturised and travels through a patient's lungs, encountering mucus build-up and passages with inflammation, which create blockages. The objective is to select and apply the appropriate treatment to affected areas, using a controller, clearing as many airways as possible within a limited time to help the patient breathe more easily.

Development of the session

On Friday 28 February 2025, the NIHR Imperial BRC Respiratory Theme collaborated with the NIHR Nottingham BRC and the BIOREME network to undertake a session at the Imperial College London Invention Rooms. The session aimed to evaluate BIOREME's Virtual Reality (VR) project with Community Partners and people with lived experience of lung diseases.

For this session PERC collaborated with Dr Anne Canning, BIOREME's Project Manager and the Imperial BRC Respiratory Theme Public Involvement, Engagement and Participation (PPIEP) Leads, Katharine Lodge and Mary Abkir. Prior to the session, we held a briefing call to discuss the aims and structure of the session. PERC designed the session's flyer (see **Appendix A**), provided guidance on the registration and feedback forms and circulated the opportunity to the

Imperial BRC's Community Partners. Draft slides were provided in advance and some amendments were made to ensure that these were accessible.

The session was co-presented by:

- Dr Anne Canning, Project Manager, BIOREME project, University of Nottingham
- Dr Carl Whitfield, Dame Kathleen Ollerenshaw Postdoctoral Fellow in Mathematical modelling, BIOREME theme lead, University of Manchester
- Dr Ellie Queck, Clinical Research Fellow, National Heart & Lung Institute, Imperial College London

Format of the session

- 1.00pm | Welcome, light lunch and refreshments
- 1.15pm | Introductory presentation on the BIOREME network and the VR project
- 1.30pm | Interactive activity using the VR headset
- 2pm | Feedback and group discussion
- 2.30pm | Close

Aims of the session

- Introducing the BIOREME network to Community Partners and people with lived experience of asthma and Chronic obstructive pulmonary disease (COPD).
- Introducing the aims and scope of the VR project and how to use a VR headset.
- Experiencing the VR game and receiving feedback on its design.
- Enhancing collaboration across NIHR Biomedical Research Centres in the UK.

Attendees

The session was disseminated through the Imperial BRC's Community Partner mailing list and the Westminster Breathe Easy group. 15 people expressed interest in the session with 8 of them attending in person. In the registration form, people were asked to provide their demographic details (voluntarily) (see details of attendee demographics at **Appendix B**).

Agenda of the session

During the session, the following topics were covered:

- Introduction of the BIOREME team
- What is the BIOREME network?
- What is VR?
- Which are the aims of the BIOREME VR project?
    - To create a game which allows users to travel through the lungs to:
        - Introduce how the airways of the lungs work
        - Introduce lung diseases and how they affect the airways
        - Introduce different inhaled treatments

        - Have fun and start a conversation
- How does a VR headset work?
- Demonstration of a VR environment with the aims to:
    - To understand what the player can see
    - To introduce the hand controls and key buttons
    - To introduce breath-controlled mechanism and controller
- Experience the VR lung game with and/or without the breath-controlled functionality
- Feedback and evaluate the experience

Remuneration and expenses

All attendees were renumerated for their time to attend the session in accordance with NIHR payment rates for public involvement in research. Attendees' reasonable travel expenses were also reimbursed. A light lunch and refreshments were also provided.

Questions asked by attendees during the session:

- How can we use VR for preventative care?
- How can we use this tool to educate people about using inhalers?
    - The BIOREME team replied that this VR game is developed as an educational tool that will be used as a public engagement activity in science festivals and not as a healthcare tool.

Session feedback

At the end of the session, the BIOREME team shared a printed feedback form (**Appendix C**) with all the attendees to explore the experience of the attendees, including what worked well, what could be improved and questions asking for feedback on the VR game. 8 responses were received. Overall, all attendees really liked the game concept, the visuals and the breath control functionality. In general, they found it quite fun and learnt something about the lungs and treatments and using the VR headset? left them wanting to find out more. They could see the game being used at science fairs and for school groups. There was some confusion around how to operate the character and which controller to use, but once people got the hang of it, they enjoyed it.

Summarised below are the main areas of feedback on the VR game:

Operability

- In general attendees understood the game and concept but took a few steps and navigation to familiase themselves (e.g. going through a couple of lung blockages). Some players were unsure if or how they can control the character to move forward/sideways

- There is a need to include clearer direction at the start of the game on the function of left and right and if using the trigger, which trigger.

Game experience

- All attendees really liked the overall concept of being sent on a mission and entering the lungs to clear blockages. They found it very fun, and the breath control function was thought to be 'very cool'. There was only one comment on feeling unstable and dizzy while playing the game.
- The game seems a bit slow at the beginning and there is quite a long wait between actions (some attendees didn't mind this as they enjoyed looking around)
- Sometimes the bronchoconstriction was harder to see. There was a suggestion to make it glow bit brighter.
- Some attendees questioned why the person was "swimming through the air"
- Some attendees felt, when they did not succeed in the game by clearing the mucus they came away feeling negative
- There was also a concern raised about language used to ensure that if players didn't clear the blockages that this was due to the game experience and design rather than the effectiveness of the treatment.
- There was a suggestion to add an option to skip the introduction and go straight to the person flying through the airways.
- Within the introduction, for first timers, attendees suggested to add a "test blow" for each device to check that users are doing it correctly, which only moves forward when the test blow is successful.
- There was a disconnection between the voiceover versus the pace of the game.

Audio

- Overall, the audio in the game was very positive and rated as loud, clear and informative.
- There was a suggestion to update the voiceover text to be more positive when the blockages weren't cleared (this was raised by several attendees informally too). The voiceover text could be improved with the voiceover artist.

Visuals

- Overall attendees thought the visuals were brilliant, good colour tone, very creative, seemed realistic
- The suggestions made were about making the scoring visual more contrasting to be easier to see the percentage complete throughout the game but also making the airways smaller as you get closer to the alveoli.

Education

- Overall attendees went away having learnt something new about the lungs. In particular, they learnt:
    - how the lungs can be blocked (mucus and muscle)
    - how dense the airways get
    - how 3D the lung tissue is
    - how complex the lungs are and why medication needs to be carefully designed
    - the purpose of inhalers.
- Overall people were interested in finding out more about the lungs and how they function. For some, the game responses made it unclear whether the treatments offered are normally effective and they would like to know more about how the treatments work.
- It would be great to provide some educational material together with the game.
- Another point raised, was that in real life, there is no airflow at the end of the lungs (alveoli).

Accessibility

- Attendees felt that is it great that there is the option to blow or use triggers as well as being able to play the game standing up or sitting down.
- It was suggested that clearer instructions are needed for people who are neurodivergent

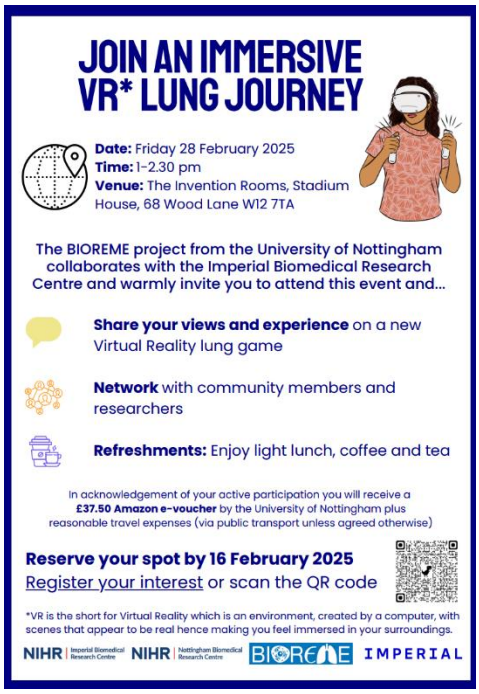
Actions

Actions	**Outcome**
• To edit the script and introductory visuals so that it is clearer what the left- and right-hand controller do • To do a practice with each hand directed by the voiceover to blow and press the trigger before entering the body, to ensure players understand and aren't distracted by struggling to play the game.	The game was updated to include a demo before entering the lungs to provide better direction on how to use the controllers and the breath control function
• To edit script responses when blockage isn't cleared to sound more positive	The script was updated with more positive wording chosen
• To include an explanation in the introduction about how the character moves through the lungs (by leaning body or pressing controllers)	It was clarified with the developer that the character automatically travels through the lungs, this is not controlled by the player.
• To significantly reduce time spent on scene when character is swimming through the air to the person	This time was reduced
• To make the character move forward more quickly when the script talks about	The script was edited to remove this text

'moving fast'. This should be checked whether it affects motion sickness.	
• To make the airways more obviously narrower as you go deeper into the lungs	This was actioned by the developer
• To make the glowing bronchoconstriction a little brighter / stand out a bit more	This was actioned by the developer
• To make the characters control screen in more contrasting colours so it can be easier for players to see what % they are clearing as they go.	This was actioned by the developer
• At end of the game to make the score bigger on the screen (would be great alongside the image of the lungs with successful/ unsuccessful clearances marked (as is already planned))	This was actioned by the developer. A visual of the lungs and their airways can now be seen at the end of the game with the path the player took through the lungs and the blockages successfully/ unsuccessfully cleared.
• To add a "skip introduction" option for people e.g. if at a science fair and they've seen the intro lots of times by previous users and are confident with VR, it can skip straight to the character flying to Malcolm.	This option already existed in the game, we now have clarification on how to use it and how to help players manipulate the controls
• To make or signpost to educational materials for users alongside game	This will be actioned by the BIOREME team and made available alongside the game.
• To create instructions for people to introduce the game at fairs etc. to users to be made available alongside game.	This will be actioned by the BIOREME team and made available alongside the game.
• To send credits and logos	The logos and credits have been updated to acknowledge everyone's input.

Appendix A

The flyer created by the PERC team to share the opportunity with Community Partners and people with lived experience.



Appendix B

Demographics of attendees (provided voluntarily), as provided through the expression of interest form.

Characteristics	**n**
Age (in years)	
26 to 39	1
40 – 49	1
50 – 59	1
60+	5
Ethnic group (self-reported)	
Indian	1
African	1
Any other White Background	2
English/ Welsh/ Scottish / Northern Irish / British	4
Gender (self-reported)	
Woman	6
Man	2

Appendix C

Printed feedback form, developed by the BIOREME team, to record experiences of the VR game.

An Immersive Lung Journey - Community Partner Feedback form (anonymous)

Many thanks for taking part in this focus group, we really appreciate your time and input.
After you have played the game, please complete the feedback form below. All responses are to remain anonymous.
Please note: The BIOREME network is hosted at the University of Nottingham and your data will be processed and stored

General

1. On a scale of 1 to 10, how would you rate the overall experience with the game, 1 being Very poor and 10 being excellent.

0	1	2	3	4	5	6	7	8	9	10

Very poor Excellent

2. Why have you given this rating?

3. What was the most enjoyable part of the game?

4. What was the least enjoyable part of the game?

5. What did you think about the audio (sounds) design?

6. What did you think about the visual designs?

Accessibility

7. On a scale of 1 to 10, how easy was the game to play?

0	1	2	3	4	5	6	7	8	9	10

Very difficult — Very easy

8. Please provide further details

9. On a scale of 1 to 10, how much discomfort did using your breath to play the game cause you?

0	1	2	3	4	5	6	7	8	9	10

None at all — High levels of discomfort

10. Please provide further details

11. On a scale of 1 to 10, how clear were the instructions to play the game?

0	1	2	3	4	5	6	7	8	9	10

Not clear at all — Very clear

12. Please provide further details

13. Did you notice any accessibility barriers? If so, what are they?

14. What type of adjustments, if any, would you recommend to improve the level of accessibility of the game?

Educational aspects

15. What did you learn, if anything, about the lung and / or lung conditions from playing the game?

16. Did you feel the educational content was relevant and accurate? Please elaborate.

17. On a scale of 1 to 10, did this game help you to better understand lung diseases?

0	1	2	3	4	5	6	7	8	9	10

Not at all — Extremely

18. Please provide further details

Looking forward

19. Are there any changes you would like to see to make the game more enjoyable or useful?

20. Are there any areas the game could be expanded or improved? Please elaborate.

21. How do you see this game being used?

22. How likely are you to recommend us to a friend or colleague?

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

23. Please provide further details

24. Do you have any other comments on this game?