Dimensionless parameters to distinguish health from disease

Speaker

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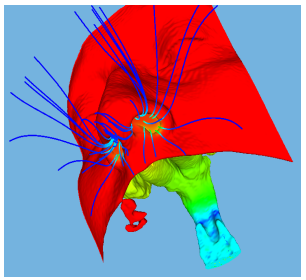

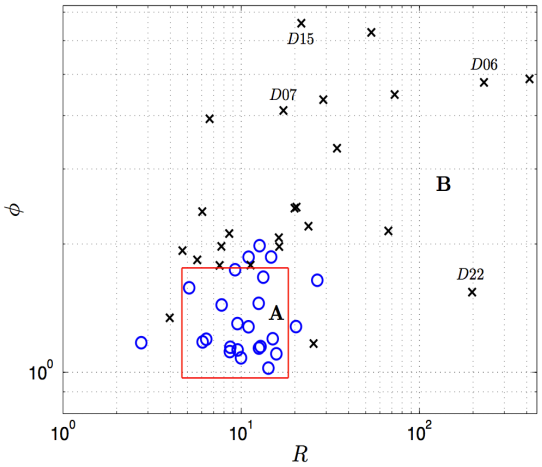

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INTRODUCTION

- Computational Fluid Dynamics (CDF), based on the discretization of the Navier-Stokes equations that govern flows, has been applied to different fields of Medicine in the last two decades

- Thus, CFD is a non-intrusive tool that is offering a multitude of possibilities in the ENT field

- The phases that are necessary to perform CFD simulations of the airflow into a nasal cavity are three:

  I. *Postprocessing of DICOM images (Digital Imaging and Communications in Medicine) obtained from computed tomography (CT) or magnetic resonance imaging (MRI) to obtain the 3D geometry of the cavity and the computational mesh*
  II. *Numerical simulations of the nasal airflow using appropriate boundary conditions and computational solver*
  III. *Postprocessing the results from the numerical simulations*

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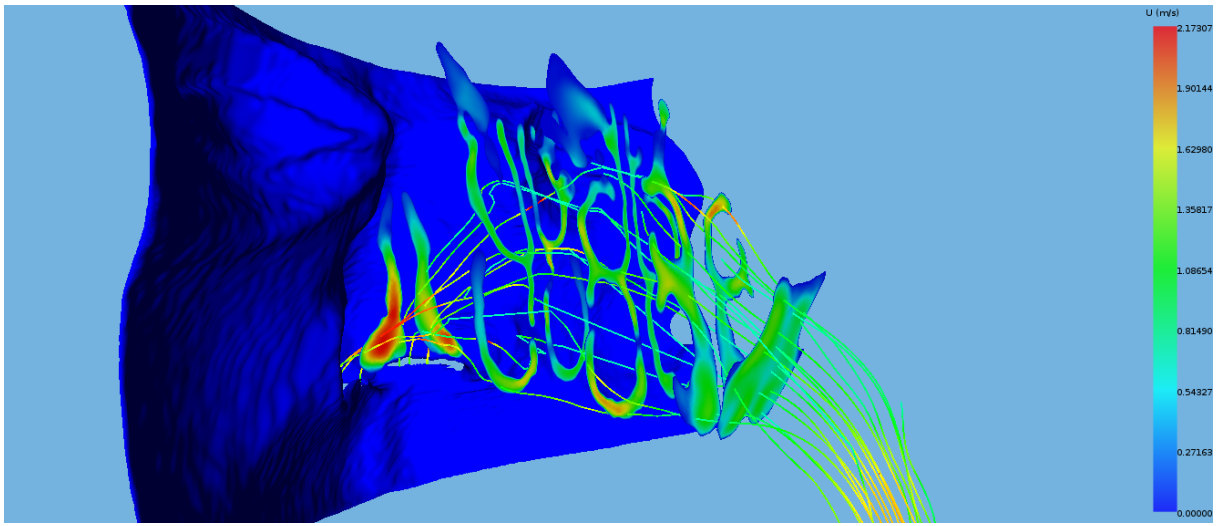
OPEN QUESTION

What is a normal nasal airflow?



Streamlines and velocity contours found with MECOMLAND. Healthy subject

K. Zhao, J. Jiang, *What is normal nasal airflow? A computational study of 22 healthy adults*, International Forum of Allergy & Rhinology **4 (6)** (2014) 435–446

Zhao *et al.* concluded: No correlation is observed in flows for healthy subjects???

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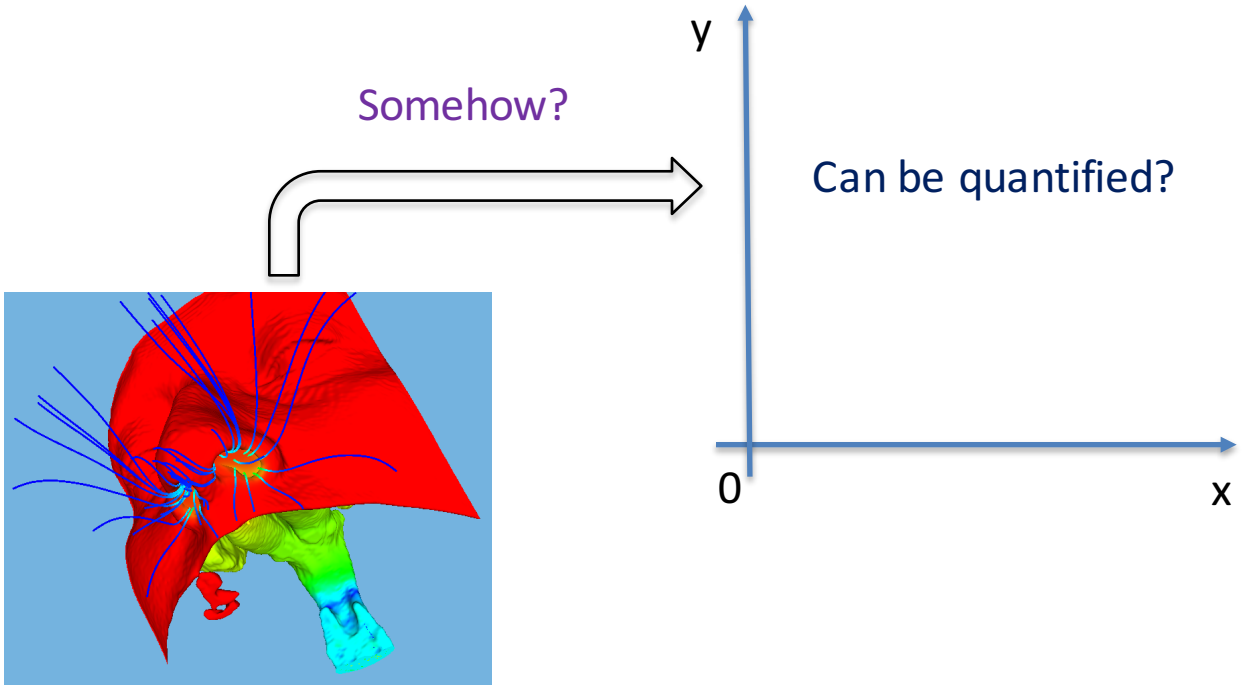

CFD information

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NEW DIMENSIONLESS ESTIMATORS

Sanmiguel-Rojas E., Burgos, M.A, del Pino C., Sevilla-García M.A., Esteban-Ortega F., M. *Robust nondimensional estimators to assess the nasal airflow in health and disease*. Inter. J. for Numerical Methods in Biomedical Engineering (2017). DOI: 10.1002/cnm.2906

$$\phi = \frac{1 + \left(\frac{A_R + A_L}{2A_C} - 1\right)^2}{(1 - \epsilon p)\, q\eta + \epsilon p}$$

$$R = \left(\frac{1}{R_R} + \frac{1}{R_L}\right)^{-1}$$

$$R_R = \frac{\Delta P / Q_R}{\frac{1}{2}\rho Q_R / A_R^2} \qquad R_L = \frac{\Delta P / Q_L}{\frac{1}{2}\rho Q_L / A_L^2}$$

A_R is the area of the right nostril

A_L is the area of the left nostril

A_C is a mean nostril area

$p = A_{mi}/A_{ma}$ is the minor-to-major nostril area ratio

$q = Q_{mi}/Q_{ma}$ is the minor-to-major flow rate ratio between passages

η is a variable set by default to one, except when there is a septal perforation, then it is set to zero

Q_R and Q_L are the flow rates into each nasal passage

ΔP is the pressure drop between the atmosphere and the choana

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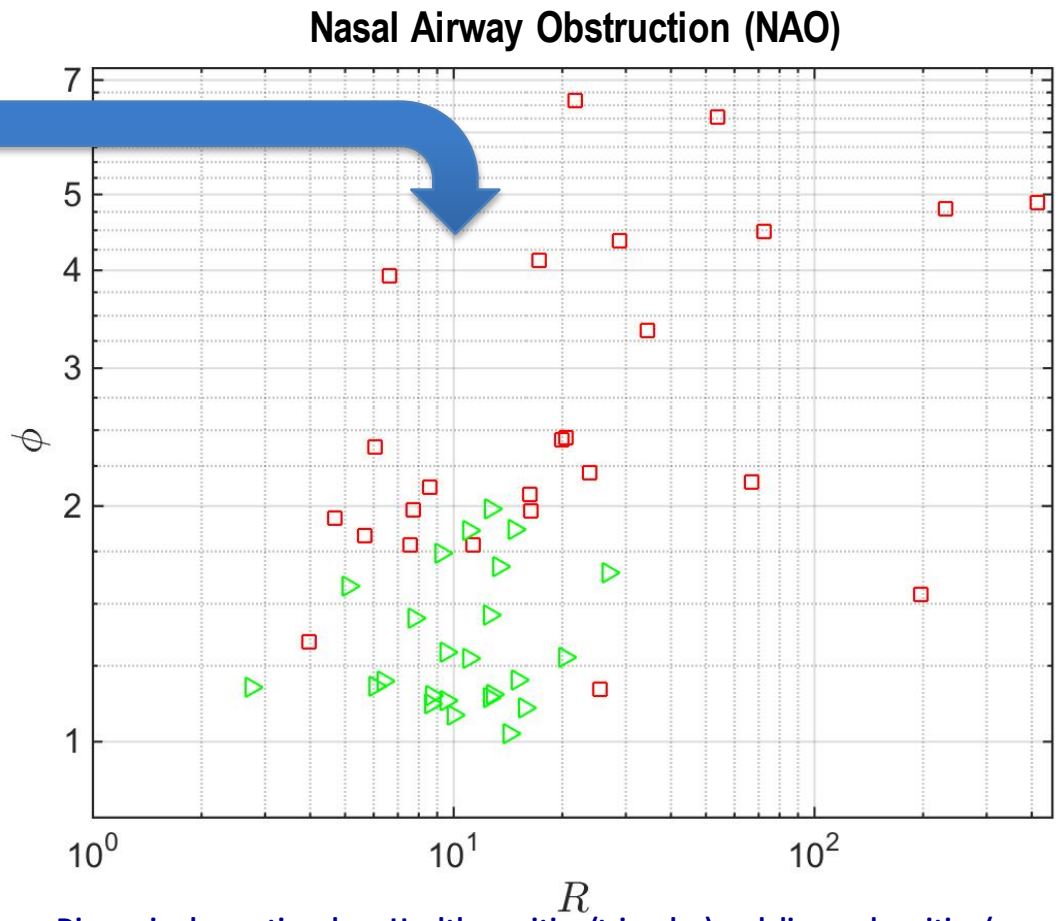

Dimensionless estimadors. Healthy cavities (triangles) and diseased cavities (squares)

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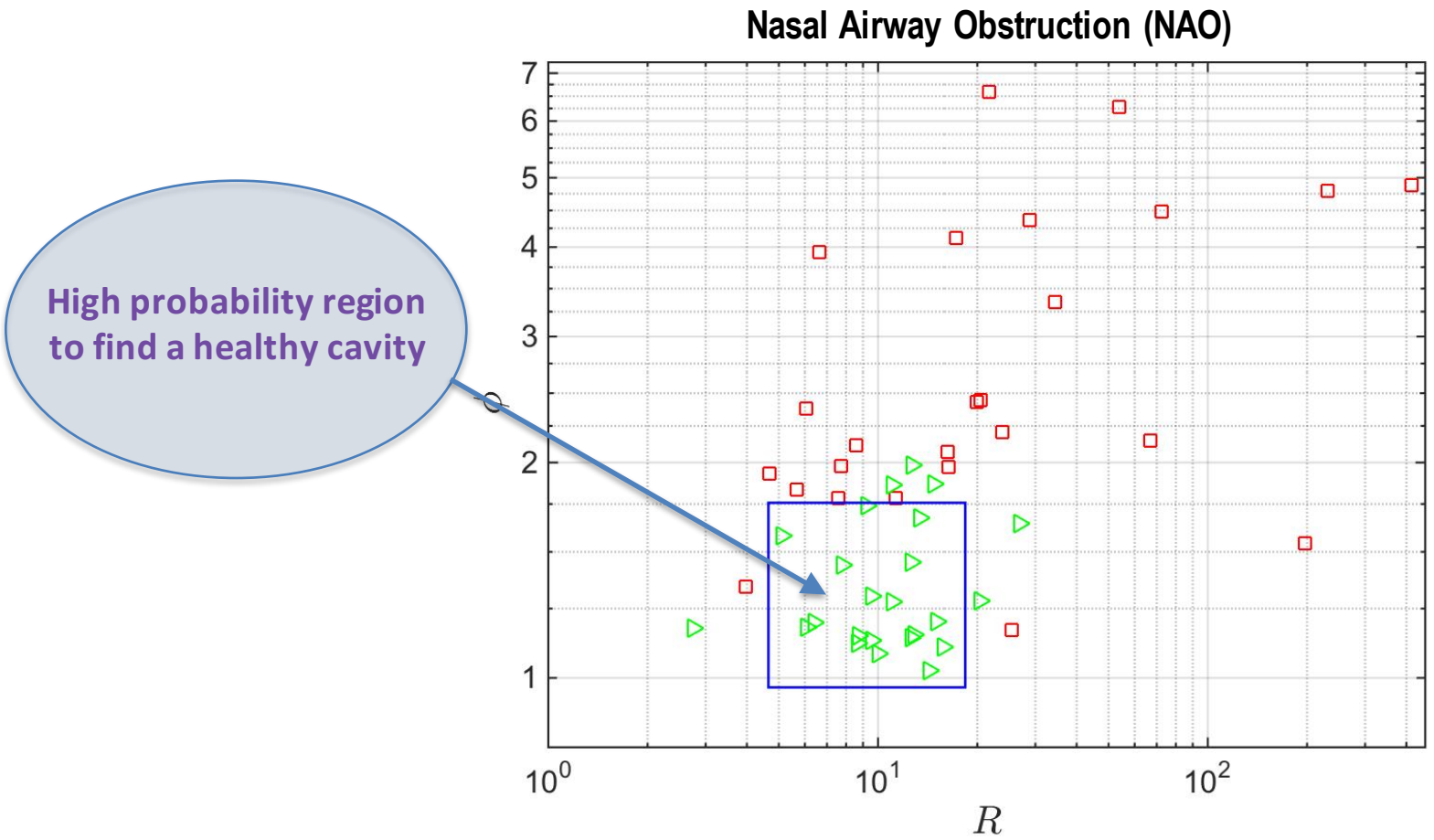
NEW DIMENSIONLESS ESTIMATORS: Statistical analysis

Sanmiguel-Rojas E., Burgos, M.A, del Pino C., Sevilla-García M.A., Esteban-Ortega F., M. *Robust nondimensional estimators to assess the nasal airflow in health and disease*. Inter. J. for Numerical Methods in Biomedical Engineering (2017). DOI: 10.1002/cnm.2906



Blue rectangle is the region of high probability to find a healthy cavity

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CONCLUSIONS

- Two new ϕ-R mathematical estimators based on computer-aided diagnosis are introduced
- These dimensionless estimators are calculated from CFD results and geometrical features of the nasal cavity
- 24 healthy subjects and 25 patients have been analyzed in this study
- The values for healthy cavities are clustered into a small rectangle region
- The values for diseased cavities are dispersed

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Thank you very much for your attention!

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