Abstract Submitted
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Beyond the mucus escalator: Complex ciliary hydrodynamics in disease and function JANNA NAWROTH, Harvard University, HANLIANG GUO, University of Southern California, DABIRI JOHN , Stanford University, EVA KANSO, University of Southern California, MARGARET MCFALL-NGAI, University of Hawaii at Manoa — Cilia are microscopic, hair-like structures lining external and internal body surfaces where they interact with fluids. The main function of motile cilia is often described as that of a "mucus escalator", i.e., a homogeneous ciliary carpet moving along layer of mucus along the surface to transport food, germ cells, debris, or pathogens. Accordingly, the performance of ciliary systems is usually measured in terms of a single metric, transport velocity, or its presumed proxy, ciliary beat frequency. We challenge this simple view through the observation that both healthy and diseased biological systems exhibit a variety of cilia morphologies, beat patterns, and arrangements, resulting in complex flow patterns and transport phenomena that cannot be reduced to a single parameter. Here we present two case studies. In one system, the ciliated surface creates two distinct flow regimes for first trapping and then sheltering potential symbiont bacteria for further biochemical screening. In the other system, chronic disease induces a misalignment of ciliary beat, leading to a pathological transition from uniform mucus transport to a pattern of stagnation and circulation. These studies suggest that (a), we need to develop a wider range of metrics for describing ciliary transport in biological and clinical contexts, and (b), engineered ciliated systems exploiting a variety of design parameters could provide novel ways of manipulating fluids at the microscale.

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