A fast point-of-care PCR test for infectious diseases based on aerosol capturing

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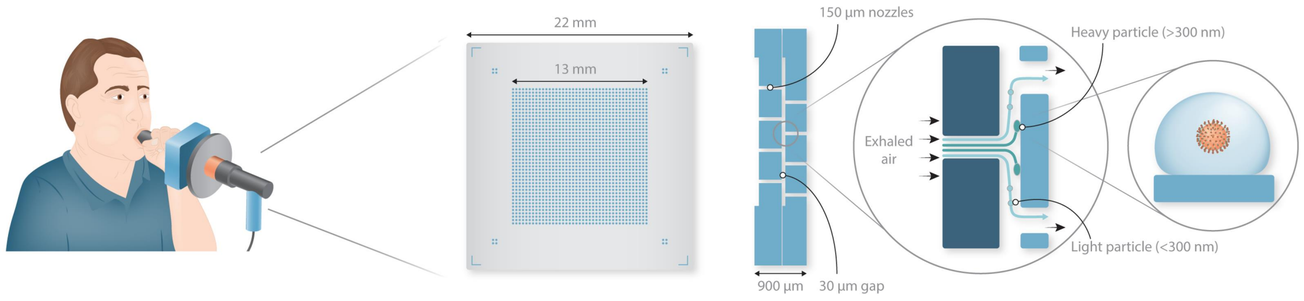
Introduction

The covid-19 pandemic quickly revealed the limitations of existing diagnostic capabilities: while rapid antigen tests are not sufficiently reliable, turnaround-time of the golden standard nasopharyngeal swab test remains cumbersome. Swab collection is invasive and uncomfortable, and existing tests detect infection, not transmissibility.

Aim

Therefore, we set out to develop a reliable, low-barrier and ultra-fast breath test that allows detecting infectiousness instead of infection.

1 We developed a silicon impactor to capture aerosols



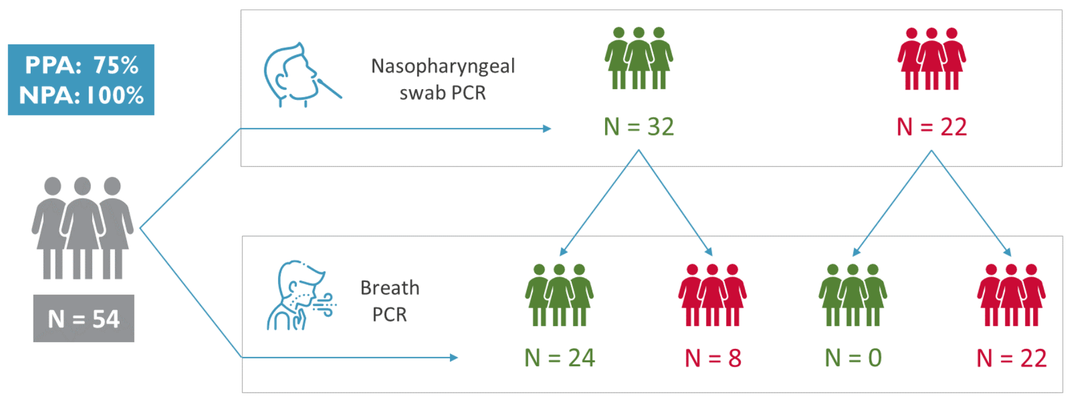
Method

We designed, developed and tested a novel approach where exhaled particles are efficiently sampled using inertial impaction in a micro-machined silicon chip, followed by a qPCR molecular assay to detect SARS-CoV-2 shedding.

2 qPCR on breath samples showed good overall accordance

Method

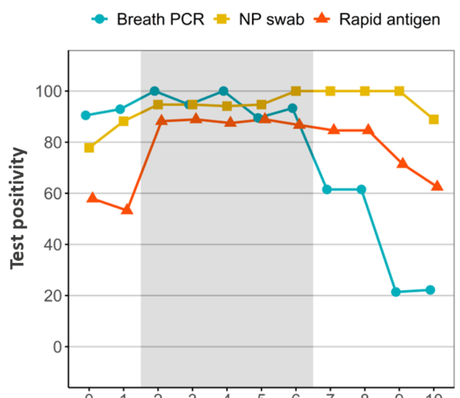
We performed a first clinical study with hospitalized positive patients (N=32) and negative healthy volunteers (N=22). Of the 32 positive patients (confirmed by NP swab qPCR), 24 tested positive by qPCR on exhaled breath samples (75% positive agreement). All swab-negatives also tested negative on breath (100% negative agreement). Follow-up studies showed near 100% sensitivity in the first week (see next).



3 Longitudinal data proofs early superiority of the breath test

Method

In a second clinical study, we screened immuno-naïve alpha-infected (N=11) and partly-boosted omicron-infected (N=8) patients as high-risk contacts and followed them up longitudinally for 1 week after their first positive test results.



Results

Sensitivity of qPCR on exhaled breath superseded that of rapid antigen tests and matched NP swab sensitivity in the beginning of the infection, yet does not suffer from prolonged positivity. This pattern is compatible with an infectiousness test.

4 On-chip PCR enables a fast point-of-care test

Material

Breath sampler

PCR instrument

Integrated workflow

Method

We developed an integrated workflow allowing to fill and seal the silicon impactor in the breath sampler and run ultra-fast qPCR on the chip (~15 min).

In a third clinical study, we compared this integrated workflow to a non-integrated workflow where PCR was performed off-chip in confirmed covid-19 subjects (n=40). A significant correlation of the Ct values for the integrated and non-integrated workflow demonstrated the potential of a fast and sensitive point-of-care test.

Results