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Viral load of SARS-CoV-2 in clinical samples

An outbreak caused by a novel human coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first detected in Wuhan in December 2019,[1] and has since spread within China and to other countries. Real-time RT-PCR assays are recommended for diagnosis of SARS-CoV-2 infection.[2] However, viral dynamics in infected patients are still yet to be fully determined. Here, we report our findings from different types of clinical specimens collected from 82 infected individuals.

Serial samples (throat swabs, sputum, urine, and stool) from two patients in Beijing were collected daily after their hospitalisation (patient 1, days 3–12 post-onset; patient 2, days 4–15 post-onset). These samples were examined by an N-gene-specific quantitative RT-PCR assay, as described elsewhere.[3] The viral loads in throat swab and sputum samples peaked at around 5–6 days after symptom onset, ranging from around 10^4 to 10^7 copies per mL during this time (figure A, B). This pattern of changes in viral load is distinct from the one observed in patients with SARS, which normally peaked at around 10 days after onset.[4] Sputum samples generally showed higher viral loads than throat swab samples. No viral RNA was detected in urine or stool samples from these two patients.

We also studied respiratory samples (nasal [n=1] and throat swabs [n=67], and sputum [n=42]) collected from 80 individuals at different stages of infection. The viral loads ranged from 641 copies per mL to $1{\cdot}34 \times 10^{11}$ copies per mL, with a median of $7{\cdot}99 \times 10^4$ in throat samples and $7{\cdot}52 \times 10^5$ in sputum samples (figure C). The only nasal swab tested in this study (taken on day 3 post-onset) showed a viral load of $1{\cdot}69 \times 10^5$ copies per mL. Overall, the viral load early after onset was high ($>1 \times 10^6$ copies per mL). However, a sputum sample collected

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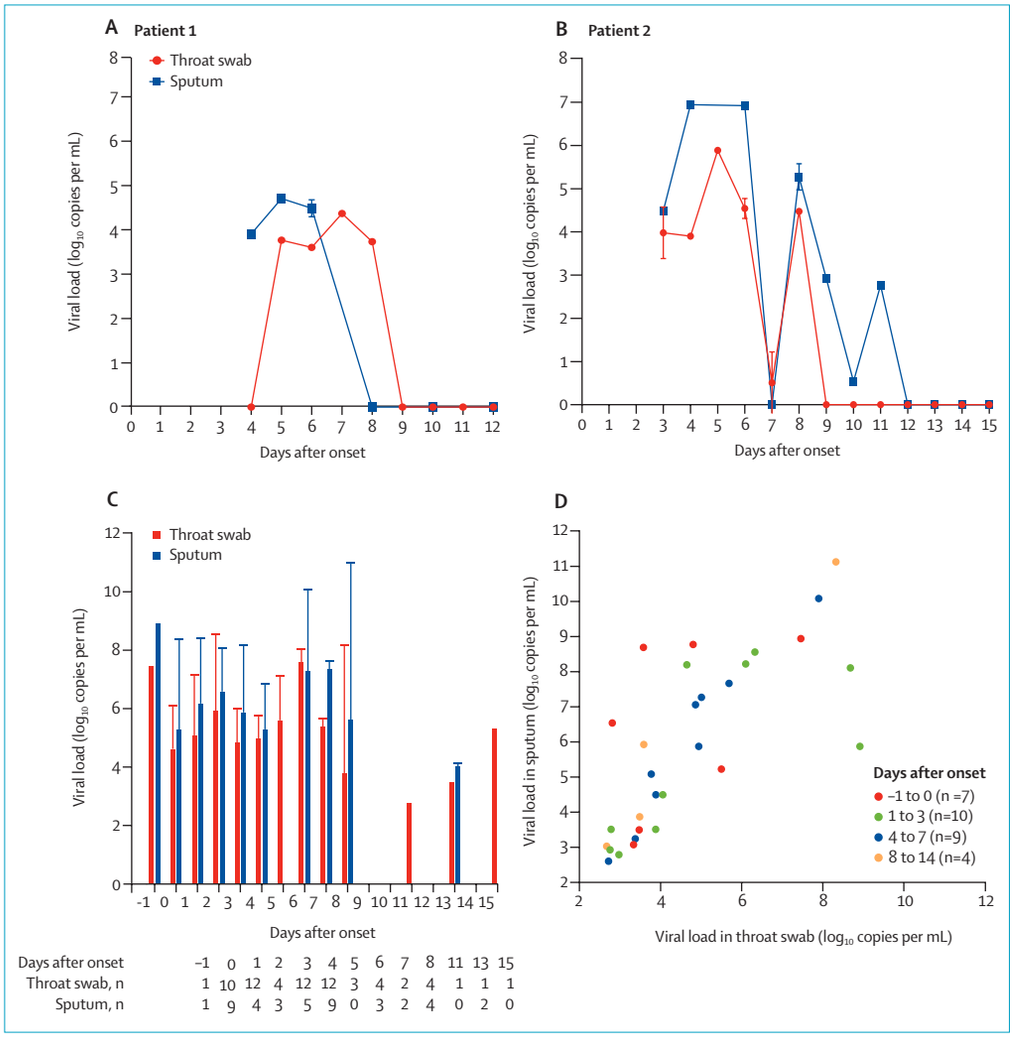

***Figure*: Viral dynamics of SARS-CoV-2 in infected patients**
Viral load (mean [SD]) from serial throat swab and sputum samples in patient 1 (A) and patient 2 (B). (C) Viral load (median [IQR]) in throat and sputum samples collected from 80 patients at different stages after disease onset. (D) Correlation between viral load in throat swab samples and viral load in sputum samples.

on day 8 post-onset from a patient who died had a very high viral load ($1{\cdot}34 \times 10^{11}$ copies per mL). Notably, two individuals, who were under active surveillance because of a history of exposure to SARS-CoV-2-infected patients showed positive results on RT-PCR a day before onset, suggesting that infected individuals can be infectious before them become symptomatic.

Among the 30 pairs of throat swab and sputum samples available, viral loads were significantly correlated between the two sample types for days 1–3 (R^2=0·50, p=0·022), days 4–7 (R^2=0·93, p<0·001), and days 7–14 (R^2=0·95, p=0·028).

From 17 confirmed cases of SARS-CoV-2 infection with available data (representing days 0–13 after onset), stool samples from nine (53%; days 0–11 after onset) were positive on RT-PCR analysis. Although the viral loads were less than those of respiratory samples (range 550 copies per mL to $1{\cdot}21 \times 10^{5}$ copies per mL), precautionary measures should be considered when handling faecal samples.

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