

Pooled Laboratory Testing for COVID -19

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Background

SARS-COV-2 mass diagnostic screening is essential to disrupt its transmission and spread. Gold standard RT-qPCR testing capacity is limited, time consuming, and resource intensive. Pooled testing or group testing provides a solution. Pooled testing was first introduced in 1943 and recently applied in the context of COVID screening. Here we describe a novel high throughput workflow implemented in our laboratory to screen high volumes of specimens and discuss optimal sample size selection.

Methods

As depicted in the workflow diagram the client portal generates orders with patient identifier and transmit them to Epic Beaker. A human readable (Accession) and machine-readable (Instrument) IDs are transmitted back to the client portal, which creates barcoded labels. Three robots pool specimens on 384 well plates containing RT-qPCR reagents and documents the relationship of pool to the individual specimens. RT-qPCR is performed by QuantStudio. If a pool tests positive or indeterminate, the specimens are identified and run individually. We leveraged the formula below to determine the likelihood of a pool being positive and the optimal sample size for our pools.

P (probability of pool to be positive) = $1 - (1 - \text{prevalence of infection}) ^ \text{pooled sample size}$

Results

From Jan 1 to Mar 8, 2021 our laboratory processed 19,634 individual samples averaging 59 pools/day or 297 samples/day. 3-5% of pools/day test intermittent/positive requiring individual samples to be retested. Using a pool size of 5 our laboratory can handle more than 6,000 pooled/test per day (30,000 individuals/day). Assuming 5% of pools testing positive, 1500 samples would require individual retesting thus 7500 reactions to test 30,000 individual samples. Currently, pooling samples in batches of 5 provides us with savings of ~74% PCR reactions/day.

Conclusions

“Optimal pool size” is challenging as it varies with infection prevalence, testing frequency, and assay sensitivity of the assay. Pool size is naturally limited due to increased prevalence of false negativity and low viral load in group testing combining too many samples. Our table allows laboratories to determine the optimal pool size considering the prevalence of positive swabs in their community and confirmed that a pool of 5 was optimal in our patient population.