Decentralized COVID-19 testing by means of nanoparticle-based one-step loop-mediated isothermal amplification assay

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Abstract: The COVID-19 pandemic has triggered an urgent need for decentralized, reliable, rapid, and simple diagnostic methods. The gold standard test for the detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; the causative agent of COVID-19) is real-time reverse transcription–polymerase chain reaction (RT-PCR), which is however mainly limited to centralized laboratories due to the need of bulky and expensive instruments (thermocycling-based amplification and fluorescence-based detection). For decentralized COVID-19 testing, reverse transcription–loop-mediated isothermal amplification (RT-LAMP) has received great attention due to its simple temperature control (constant temperature at 65 °C) and short assay time (less than 45 minutes versus 2–4 hours for RT-PCR). In this presentation, we will share two new types of nanoparticle-based RT-LAMP assay platforms developed by our team with assay performances consistent with RT-PCR, including gold nanoparticle (AuNP) and quantum dot (QD) detection probes. The first type is colorimetric (thiolated poly(ethylene glycol) and 11-mercaptoundecanoic acid comodified AuNPs (PEG/MUA-AuNPs) and the second type is fluorescent (amine-, carboxyl-, or sulfonate-modified QDs). For a negative sample (absence of SARS-CoV-2), after incubation at 65 °C for 40 min, the detection probes remain dispersed. For a positive sample (presence of SARS-CoV-2), magnesium pyrophosphate crystals are formed as one of the reaction products. The detection probes bind with magnesium pyrophosphate crystals, resulting in their coprecipitation and thus a colored (AuNPs)/fluorescent (QDs) precipitate is observed. We also developed handheld and low-cost devices for real-time monitoring of the colorimetric/fluorescent LAMP reaction (i.e., precipitation of AuNPs/QDs). Importantly, we will present the validation results with clinical samples.

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