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Charge-shifting polyplex as a viral RNA extraction carrier for streamlined detection of infectious viruses

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Abstract

The recent outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has highlighted the need for rapid, user-friendly nucleic acid testing that involves simple but efficient RNA extraction. Here, we present a charge-shifting polyplex as an RNA extraction carrier for advanced diagnosis of infectious viral diseases. The polyplex comprises poly(2-(dimethylamino) ethyl acrylate) (pDMAEA) electrostatically conjugated with RNA. The pDMAEA film can rapidly dissolve in the viral RNA solution, promoting immediate binding with RNA to form the polyplex, which enables the efficient capture of a substantial quantity of RNA. Subsequently, the captured RNA can be readily released by the quick hydrolysis of pDMAEA at the onset of quantitative reverse transcription-polymerase chain reaction (qRT-PCR), streamlining the entire process from RNA extraction to analysis. The developed method requires only 5 min of centrifugation and enables the detection of RNA in a one-pot setup. Moreover, the proposed method is fully compatible with high-speed qRT-PCR kits and can identify clinical samples within 1 h including the entire extraction to detection procedure. Indeed, the method successfully detected influenza viruses, SARS-CoV-2, and their delta and

omicron variants in 260 clinical samples with a sensitivity of 99.4% and specificity of 98.9%. This rapid, user-friendly polyplex-based approach represents a significant breakthrough in molecular diagnostics.

논문정보

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