

Chapter 13

Application of UPT-POCT in Public Health Emergencies



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Abstract Rapid and reliable detection of infectious agents on site is essential for timely initiation of medical treatment and post-exposure prophylactic measures when public health emergencies occur. However, the referee standard for confirmation of infectious agents remains laboratory diagnosis, which is time-consuming and not available in the field. UPT-POCT technology is a versatile tool that requires limited resources and can realize rapid detection of infectious agents on site, providing timely information for the quick response to public health emergencies.

Keywords Public health emergency · POCT · UPT technology

13.1 Introduction

Since the 21st century, public health emergencies have occurred frequently in countries around the world, such as the outbreak of SARS in 2003, the H1N1 flu in 2009, the Ebola outbreak in 2014, and the outbreak of the African swine fever in 2018, etc. Public health emergencies have obvious unpredictability, seriously threatening people's health and social economic development. In order to minimize its impact, the risk factors should be quickly and accurately processed and eliminated after a public health emergency occurs, which puts higher requirements on the field detection technology.

When a public health emergency occurs, suspicious samples are usually transported to the laboratory for routine bioassay. However, it is difficult to provide

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timely feedback because the transportation process and the testing process take a lot of time (Rongkard et al. 2016). Compared with conventional laboratory technology, POCT technology has the characteristics of fast detection, simple operation, and low requirements for instruments and operators, which is more suitable for application in public health events (Luppa et al. 2011). POCT technology can provide analytic results in the shortest time, providing important reference and evidence for relevant departments.

13.2 Diagnostic Methods for Public Health Emergencies

The gold standard for microbiological testing mainly relies on techniques such as separation and culture, morphological microscopy, and biochemical identification (Bloomfield et al. 2015). Such methods cannot meet the need for rapid and accurate detection of pathogens in the field because of its long period and complicated operation. In addition, there are some other conventional detection methods, such as enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR), which are faster than the gold standard method. However, these methods are also difficult to carry out in field conditions (Eriksson and Aspan 2007). The PCR method has been widely used in laboratories and hospitals. In order to detect the target gene of pathogens, it needs to extract and purify the genome in the sample first, and then detect the target gene with specific primers (Wisselink et al. 2017). The operation is complicated, and it takes 1–2 h to obtain the result. The colloidal gold based-immunoassay has the characteristics of low cost, simple operation, and rapid detection (within 15 min). It has been widely used as a rapid diagnostic tool, and is suitable for on-site detections. However, it is not sensitive and accurate enough, and it cannot provide quantitative result (Song et al. 2016).

UPT-POCT technology is a new detection technology that combines UPT technology, immunochromatography technology and biosensor technology. UPT-POCT technology uses UCPs as detecting labels, which has a unique up-conversion luminescence of emitting visible light (high energy) under the excitation of infrared light (low energy). This unique property makes it an excellent optic label with many advantages, such as no background interference, no quenching, and suitable for quantitative analysis. The development of UPT-POCT technology has obviously increased the sensitivity and stability of immunochromatography technology, and could complete quantitative detection with portable devices within 15 min (Hua et al. 2015).

13.3 The Application of UPT-POCT in Public Health Emergencies

UPT-POCT technology is suitable for the detection and analysis of various types of samples, including strong acid, alkali, high viscosity samples, powder samples, animal organ samples, and body fluid samples (Zhang et al. 2014; Li et al. 2009), which can basically meet the needs of on-site detection of public health emergencies. According to the report (Zhang et al. 2015), the UPT-POCT technology can also detect corrupt liver samples, which can meet the requirements for rapid detection of natural disease surveillance sites. The UPT-POCT kits for the detection of pathogens and viruses related public health emergency mainly includes *Yersinia pestis*, *Bacillus anthracis*, *Brucella sp.*, *Burkholderia pseudomallei*, *Francisella tularensis*, ricin, abrin, Influenza A, Influenza B, Zika and Ebola virus.

The main parameters of the above UPT-POCT diagnostic kits are as follows: (1) the sample types can be soil, powder, animal organs and body fluid samples; (2) the instrument applied is the UPT-3A biosensor series, and the reaction time is 15 min; (3) the detection results can be printed and transferred to a PC; (4) the detection sensitivity of infectious bacteria can reach 2.0×10^3 CFU/ml; there is no cross between different pathogens; the detection has good repeatability; (5) the effective period of the kits is 18 months, and the storage conditions are 4–30 °C, which can better meet the needs of on-site testing.

In summary, UPT-POCT technology has a wide range of applications in public health emergencies, providing rapid and timely detection results for related departments of disease control. At present, public health emergencies occur frequently in worldwide. The further improvement and promotion of UPT-POCT technology will provide more powerful technical support for the effective prevention and control of public health emergencies.

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