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analyte detection, all collected sample and all liquids needed to detect a specific analyte. In various embodiments, the kit includes a one-time-use sample collection device; and a one-time-use detection unit. The detection unit includes an input tunnel sized to securely and permanently receive the sample collection device, and a plurality of compartments, which separately and securely store reagents, a wash media, and a substrate. In some embodiments, the input tunnel extends from an aperture on a surface of the detection unit to an entryway of a first compartment holding the reagents. In some embodiments, prior to insertion of the sample collection device, a selectively breakable membrane covers the entryway of the first compartment to block flow of the reagents into the input tunnel. In some embodiments, complementary locking features are disposed on the sample collection device and in the input tunnel to restrict movement of the sample collection device relative to the detection unit upon insertion of the sample collection device into the input tunnel. Moreover, in some embodiments, the sample collection device and input tunnel are sized to form a liquid-tight seal as the sample collection device advances into the input tunnel.

Still a further aspect of the disclosed technology is directed to a method for detecting a disease without a healthcare provider or technician present. In some embodiments, such a method includes: rubbing an internal passage of a user's nose with a swab to collect a sample, placing a cartridge, which houses all reagents and substrates needed to perform a disease-detection testing protocol, into or onto a specialized computer configured to detect the cartridge, and inserting the swab into the cartridge such that the swab locks into place within the cartridge and cannot be removed. In various embodiments, the specialized computer senses the insertion of the swab and initiates a testing protocol. In some such embodiments, the specialized computer detects the presence or absence of a particular disease within the sample via the testing protocol in less than 30 minutes. The method may also include reading results of the test from a remote computing device, after the results are transmitted from the specialized computer to the remote computing device via a wired or wireless communication connection.

An additional aspect of the disclosure is directed to a method for detecting the presence, absence, and/or quantity of a target analyte within a sample. The method of various embodiments includes: loading a cartridge into or onto an analyte reader, wherein the cartridge has a plurality of reservoirs, including a first reservoir filled at least partially with reagents, a reservoir filled at least partially with a substrate, and optionally, another reservoir filled at least partially with a wash solution; removing a sample collection device from a sterile package; contacting a specimen with a tip of the sample collection device to collect a sample; and inserting the sample collection device into the cartridge until at least the tip enters the first reservoir. In certain embodiments, inserting the tip of the sample collection device into the first reservoir activates the analyte reader, causing a sonication device within the analyte reader to perform a sonication protocol to mix the sample collected by the sample collection device with the reagents in the first reservoir. Additionally or alternatively, inserting the tip into the first reservoir causes a series of heating elements to sequentially melt a series of valves positioned within or near the plurality of reservoirs, thereby sequentially releasing the contents of the plurality of reservoirs into an analysis zone for analysis by the analyte reader. In some such embodiments, inserting the tip of the sample collection device into the cartridge involves advancing the sample collection device into an input tunnel of the cartridge until: the tip of the sample collection device breaks a mem-

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brane barrier disposed at a distal end of the input tunnel, the tip enters the first reservoir, and the sample collection device locks into fixed engagement with the cartridge with a liquid-tight seal formed between the sample collection device and the input tunnel.

Another aspect of the disclosure is directed to computerized methods of detecting the presence, absence, and/or quantity of target analytes within a sample. For example, in some embodiments, a method performed by a computerized analyte reader includes: detecting the presence of a cartridge loaded into or onto the analyte reader, detecting identification information associated with the cartridge, and identifying a proper test protocol for the cartridge based at least in part on the identification information. In some embodiments, the computerized method additionally or alternatively includes: detecting a sample collection device inserted into a first reservoir of the cartridge, initiating a sonication protocol upon sample collection device insertion in order to mix a plurality of reagents, a plurality of magnetic particles, a plurality of detector agents or competitive binding agents, and a plurality of sample particles within the first reservoir. In some such embodiments, the plurality of magnetic particles includes at least: a plurality of large magnetic particles each having a first surface affinity molecule on its surface configured to bind to a first target analyte, and a plurality of small magnetic particles each having a second surface affinity molecule on its surface configured to bind to a second target analyte. Upon mixing, for example, via the sonication protocol, if the first and/or the second target analyte is present, hybridization occurs. In some such embodiments, particularly embodiments with detector agents, the resulting mixture includes a plurality of sandwich complexes, each formed of a target analyte bound to both a surface affinity molecule on a surface of a magnetic particle and a detector agent. In other embodiments, particularly, embodiments with a competitive binding agent, the resulting mixture includes molecule complexes each formed of a target analyte bound only to a surface affinity molecule on a surface of a magnetic particle.

In some embodiments, the method also includes stimulating a first heating element such that a first valve within the cartridge melts and the mixture flows out of the sample preparation reservoir into an analysis channel. In various embodiments, the mixture is suspended in a solution, and the solution acts as a transport medium transporting the mixture from the first reservoir into the analysis channel towards a downstream absorbent material via capillary action. Within the analysis channel, the magnetic particles of the mixture localize over a plurality of magnets or other magnetic field generators within a portion of the analysis channel; the magnetic particles thereby form a plurality of localized samples. In such embodiments, the magnetic particles localize based on size and strength such that the large magnetic particles localize within a smaller upstream magnetic field and the small magnetic particles localize within a larger downstream magnetic field. The method of some embodiments also includes stimulating a second heating element such that a second valve within the cartridge melts and a wash solution flows out of a second reservoir into the analysis channel with the wash solution removing, from the plurality of localized samples, detector agents and/or competitive binding agents that are not indirectly bound to magnetic particles. The method of some embodiments further includes stimulating a third resistive heater such that a third valve within the cartridge melts and a solution of substrates flows out of a third reservoir into the analysis channel. In some embodiments, the detector agents and competitive binding agents include oxidizing enzymes which oxidize the substrate.