

Claims

We Claim:

1. An apparatus for rapidly detecting a target molecule, compound or substance via a molecular probe whereby said apparatus comprises the following:
 - 5 a breath tube for the conveyance of condensate of EBC (exhaled breath condensate);
 - a collection receptacle;
said collection receptacle being circular as to allow for a vortex flow within said collection receptacle;
 - 10 a collection reservoir;
said collection reservoir residing at a point inferior to said collection receptacle;
said collection receptacle capable of accumulating condensate from EBC;
 - a condensate accelerator; and
 - 15 said condensate accelerator applied to or with said collection receptacle;
 - an exhaust portal;
said exhaust portal residing at a point superior to said collection receptacle;
said exhaust portal providing for the exit and expulsion of expended EBC (eEBC).

2. The apparatus of claim 1 wherein said collection receptacle has an inner surface that is hydro-phobic as to facilitate condensate movement down said surface as influenced by gravitational forces.
3. The apparatus of claim 1 wherein said condensation accelerator is device which is
5 endogenous to or exogenously adjacent to said collection receptacle.
4. The apparatus of claim 3 wherein said condensation accelerator is provided by a pre-refrigeration /pre-freezing prior to administration of ECB.
5. The apparatus of claim 3 wherein said condensation accelerator may comprise one or more of the following:
10 ice;
thermoelectric (TE) cooling;
vapor compression cooling;
refrigerant gels;
cooling liquid;
15 “cold pack” cooling (i.e., those coolants using water and ammonium nitrate, calcium ammonium nitrate or urea causing an endothermic reaction) and/or phase change gels;
heat sinks;
heat conductors;
20 exothermic reactants; and/or
endothermic reactants.
6. The apparatus of claim 1 wherein said collection receptacle, collection reservoir or a combination thereof contains molecular beacons (MBs).

7. The apparatus of claim 6 wherein said molecular beacons contain a nucleotide sequence comprising a loop and two stems whereby said stems express two fluorescent dyes or a fluorescent dye and a quencher wherein said stems express reciprocal affinity, through corresponding base pairs in a closed conformation.
- 5 8. The apparatus of claim 7 wherein said molecular beacons' loop expresses a target-specific affinity for a corresponding nucleotide sequence on a target molecule, compound or substance and wherein said target, if present, binds to said MB.
9. The apparatus of claim 8 wherein said binding of said MB and said target causes a conformational change in said MB and subsequent hybridization, creating a MB-target
10 duplex, whereby said fluorescent dye and said quencher are distanced from one another causing said fluorescent dye to fluoresce.
10. The apparatus of claim 9 wherein said fluorescence allows an observer to detect the presence of a target molecule, compound or substance as a result of MB-target binding, MB hybridization, MB conformational change, fluorescent dye and quencher created
15 distance and a non-quenched, fluorescent dye which is made to fluoresce.
11. The apparatus of claim 10 whereby said MB-target fluorescence duplex may be observable through a Multi-pixel Photon Counter (MPPC).
12. The apparatus of claim 11 whereby said MPPC is aided through the use of an ellipsoid reflective mirror which acts to direct and focus fluorescent light to said MPPC.
- 20 13. The apparatus of claim 12 whereby ellipsoid reflected light may be amplified through a non energy consuming process facilitating light passage through an aperture, through a condenser lens and through an optical bandpass filter as to concentrate said reflected fluorescent light directly into said MPPC.

14. The apparatus of claim 13 wherein said mouthpiece may exhibit a one-way valve, said exhaust portal may exhibit a filter, or a combination thereof.

15. A system for rapidly detecting a target molecule, compound or substance via a molecular probe, collection device and optical detection device whereby said system comprises the following:

5 a target-specific molecular probe and target molecule, creating a duplex, consist of (a) molecular beacon, (b) a target molecule and (c) a resultant detectable MB-target complex which becomes detectable after undergoing binding, hybridization and a conformational change as to provide sufficient distance between a fluorophore and quencher to allow for luminescence;

10 an exhaled breath condensate (EBC) receiving device comprising a mouthpiece, a tapered condensate receiving chamber, an exhaust portal and a collection reservoir, capable of capturing exhaled breath condensate (EBC) into a receiving collection receptacle to produce a sample; and

15 an optical detection device which focuses emitted fluorescent light thorough the use of an integrated ellipsoid mirror, to deliver a concentrated luminescence to a receiving detection sensor.

16. The system of claim 16 wherein said receiving tapered condensate receiving chamber must be maintained in a largely upright position and may employ means of accelerating condensate capture using said collection reservoir via one or more

20 of the following, singly or in combination, the following:

vortex flow;

cyclonic flow;
a hydrophobic interior;
gravitation force; and/or
applied cooling.

5 17. The system of claim 17 wherein said EBC receiving device may be (1) integrated into an optical detection device or (2) may be placed into a secondary device as to assure proper placement of said sample.

18. The system of claim 18 wherein said exhaled breath condensate (EBC) receiving device, said optical detection device, or a combination thereof, may be tagged,
10 labeled or otherwise inventories as to provide for proper target molecule, compound or substance identification.

19. The system of claim 15 wherein said exhaled breath condensate (EBC) receiving device and/or optical detection device, or a combination thereof, may be connected to a display device, microcontroller, a computer either directly or through a wireless
15 means (e.g., WiFi or Bluetooth).

20. A method for rapidly detecting a target molecule, compound or substance via a molecular probe, collection device and optical detection device whereby said method comprises the following steps:

- a. scanning a QR or bar code on device, patient, or a combination thereof,
20 to ensure accuracy;
- b. conducting a rapid detection test by the following:
 - i. zeroing said collection device;

- ii. checking or inserting new or charged batteries into collection device;
 - iii. inserting a new breath tube into collection device;
 - iv. ensuring both patient and device are in the upright position;
 - v. ensuring patient forms a tight seal around mouthpiece;
 - vi. triggering device;
 - vii. instructing patient to exhale into the collection device;
 - viii. collecting sufficient condensate and sample volume; and
 - ix. instructing patient to cease exhalation;
- c. placing collection device into a detection device, or if detection device is integrated, conducting a scan of the sample using focused light from the reflective ellipsoid mirror to concentrate fluorescent light, if present;
- d. alternatively, the collected sample may removed from the collection device and placed into a detection device; and
- e. conducting a sample reading using ellipsoid mirror to direct, concentrate and focus light through an aperture, through a condenser lens and optical bandpass filter and into a Multi-pixel Photon Counter whereby a sample can be analyzed quantitatively and qualitatively to determine presence and amount of target molecule, compound or substance;
- f. determining presence and quantity of target molecule, compound or substance;

- g. causing transmittance or affirming automated transmittance of collected data to a computer to an external computer via wireless, Wi-Fi or Bluetooth transmission; and
 - h. accessing collected, analyzed, stored, displayed or other computer or application processed data for qualitative and quantitative results.
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