MODULAR POINT-OF-CARE DEVICES AND USES THEREOF

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. Provisional Application No. 60/997,460, filed October 2, 2007, which application is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The discovery of a vast number of disease biomarkers and the establishment of miniaturized medical systems have opened up new avenues for the prediction, diagnosis and monitoring of treatment of diseases in a point-of-care setting. Point-of-care systems can rapidly deliver test results to medical personnel, other medical professionals and patients. Early diagnosis of a disease or disease progression can allow medical personnel to begin or modify therapy in a timely manner.

[0003] Multiplexed biomarker measurement can provide additional knowledge of the condition of a patient. For example, when monitoring the effects of a drug, three or more biomarkers can be measured in parallel. Typically, microtiter plates and other similar apparatuses have been used to perform multiplexed separation-based assays. A microtiter plate (for example, a 384 well microtiter plate) can perform a large number of assays in parallel.

[0004] In a Point-of-Care (POC) device, the number of assays that can be performed in parallel is often limited by the size of the device and the volume of the sample to be analyzed. In many POC devices, the number assays performed is about 2 to 10. A POC device capable of performing multiplexed assays on a small sample would be desirable.

[0005] A shortcoming of many multiplexed POC assay devices is the high cost of manufacturing the components of the device. If the device is disposable, the high cost of the components can make the manufacturing of a POC device impractical. Further, for multiplexed POC devices that incorporate all of the necessary reagents onboard of the device, if any one of those reagents exhibit instability, an entire manufactured lot of devices may have to be discarded even if all the other reagents are still usable.

[0006] When a customer is interested in a customizing a POC device to a particular set of analytes, manufacturers of multiplexed POC assay systems are often confronted with a need to mix-and-match the assays and reagents of the device. A multiplexed POC assay suitable to each customer can be very expensive, difficult to calibrate, and difficult to maintain quality control.

[0007] POC methods have proven to be very valuable in monitoring disease and therapy (for example, blood glucose systems in diabetes therapy, Prothrombin Time measurement in anticoagulant therapy using Warfarin). By measuring multiple markers, it is believed that complex diseases (such as cancer) and therapies such as multi-drug therapy for cancer can be better monitored and controlled.

SUMMARY OF THE INVENTION

[0008] Thus, there remains an unmet need for alternative designs of POC devices. A desirable design provides modular capture surfaces and assay incubation elements. Furthermore, modular capture surfaces and assay incubation elements need to be integrated into POC disposables suited for just-in-time (JIT) manufacturing methods. It would be desirable to provide a customizable POC device at a practical cost to user and the manufacturer. The present ~~invention~~disclosure addresses these needs and provides related advantages as well.

[0008a] In an aspect, the present invention provides a method of retrieving plasma from a blood sample comprising:

a. mixing a blood sample in the presence of magnetizable particles in a sample collection unit, wherein the magnetizable particles comprise an antibody capture surface for binding to non-plasma portions of the blood sample; and

b. applying a magnetic field above a plasma collection area to the mixed blood sample to effect suspension of the non-plasma portions of the blood sample on top of the plasma collection area, wherein said method is carried out in a system for automated detection of an analyte, said system comprising:

i) a cartridge for automated detection of an analyte, the cartridge comprising:

the sample collection unit, wherein the sample collection unit comprises the sample;

an array of assay units configured to receive a portion of the sample from the sample collection unit and run a chemical reaction that yields a detectable signal indicative of the presence of the analyte in the sample; and

an array of reagent units containing reagents for running the chemical reaction;

wherein an individual assay unit of the array of assay units and an individual reagent unit of the array of reagent units are configured to be movable into fluid communication such that reagents for running the chemical reaction are brought to contact with the portion of the sample in the assay unit; and

ii) a detection assembly for detecting the detectable signal indicative of the presence or absence of the analyte.

[0009] In an ~~aspect~~example, a cartridge is disclosed for automated detection of an analyte in a bodily fluid sample comprising: an array of addressable assay units configured to run a chemical reaction that yields a detectable signal indicative of the presence or absence of the analyte; and an array of addressable reagent units, wherein an individual

addressable reagent unit of the array is addressed to correspond to an individual addressable assay unit of the array of assay units, and wherein the individual reagent units are configured to be calibrated in reference to the corresponding individual assay unit before the arrays are assembled on the cartridge. The device can further comprise a sample collection unit configured to receive the bodily fluid sample.

[0010] In another ~~aspect~~example, a cartridge is disclosed for automated detection of an analyte in a bodily fluid sample comprising: a sample collection unit configured to receive the bodily fluid sample; an array of assay units configured to receive a portion of the sample from the sample collection unit and run a chemical reaction that yields a detectable signal indicative of the presence of the analyte in the sample; and an array of reagent units containing reagents for running the chemical reaction; wherein an individual assay unit of the array of assay units and an individual reagent unit of the array of reagents units are configured to be movable into fluid communication such that reagents for running the chemical reaction are brought to contact with the bodily fluid sample in the assay unit.

[0011] An individual reagent unit can be configured to receive a movable assay unit. In some ~~embodiments~~examples, the individual assay unit comprises an assay tip. In some ~~embodiments~~examples, the individual assay unit is configured to run an immunoassay.

[0012] The bodily fluid sample can be a blood sample. In some instances, a sample collection unit is configured to receive a volume of the bodily fluid sample about 50, 20, 10, 5 or 3 microliters or less. In an instance, the sample collection unit is configured to receive a volume of the bodily fluid sample equivalent to a single drop of blood.

[0013] A device as described herein can comprise a pretreatment unit configured to retrieve a portion of the bodily fluid sample for running the chemical reaction to detect the analyte and the pretreatment unit can be configured to retrieve plasma from whole blood sample received in the sample collection unit.

[0014] In an ~~aspect~~example, a system is described herein for automated detection of an analyte in a bodily fluid sample comprising: a device as described herein; and a detection assembly for detecting the detectable signal indicative of the presence or absence of the analyte. The system can further comprise a programmable mechanical device configured to move the individual assay unit from a first location to a second location. In some instances, a system comprises a fluid transfer device. The fluid transfer device can be a pipette and can be automated. A system can also comprise a communication assembly for transmitting a protocol based on the analyte to be detected. In some instances, a system herein comprises a heating block configured to receive an individual assay unit and can also comprise a magnetic block, for example, that can be used for separation of red cells from the sample.

[0015] In another ~~aspect~~example, a system is disclosed for automated detection of a plurality of analytes in a bodily fluid sample, comprising: a fluidic device comprising: a sample collection unit configured to contain the bodily fluid sample; an array of assay units, wherein an individual assay unit of said array of assay units is configured to run a chemical reaction that yields a signal indicative of an individual analyte of said plurality of analytes being detected; and an array of reagent units, wherein an individual reagent unit of said array of reagent units contains a reagent; and a fluid transfer device comprising a plurality of heads, wherein an individual head of the plurality of heads is configured to engage the individual assay unit, and wherein said fluid transfer device comprises a programmable processor configured to direct fluid transfer of the bodily fluid sample from the sample collection unit and the reagent from the individual reagent unit into the individual assay unit. In some ~~embodiments~~examples, the configuration of the processor to direct fluid transfer effects a degree of dilution of the bodily fluid sample in the array of assay units to bring signals indicative of the plurality of analytes being detected within a detectable range, such that said plurality of analytes are detectable with said system.

[0016] In some instances, a bodily fluid sample comprises at least two analytes that are present at concentrations that differ by at least 2, 5, 10, 15, 50, or 100 orders of magnitude. The degree of dilution of the bodily fluid sample can bring the signals indicative of the at least two analytes within the detectable range.

[0017] A system herein can further comprise a detector configured to detect signal intensities of the detectable range. An exemplary detector is a photomultiplier and a detectable range of the detector can be about 20 to about 10 million counts.

[0018] In some ~~embodiments~~examples, wherein the individual head of a fluid transfer device is configured to adhere to the individual assay unit. The individual assay unit can provide an immunoassay reaction site. In some instances, the individual assay unit is a pipette tip. The fluid transfer device can be a pipette such as an air-displacement pipette. The fluid transfer device can also comprises a motor in communication with the programmable processor, wherein the motor can move said plurality of heads based on a protocol from said programmable processor.

[0019] In another ~~aspect~~example, a system is described herein for automated detection of a plurality of analytes in a plasma portion of a whole blood sample, comprising: a device configured to automatically receive and process the whole blood sample to yield the plasma portion, from which a detectable signal indicative of the presence or absence of the analyte of interest is generated onboard the device; and a detection assembly for detecting the detectable signal indicative of the presence or absence of the analyte.

[0020] In an ~~aspect~~example, provided herein is a method of detecting an analyte in a bodily fluid sample comprising: providing a blood sample to a device as described herein; allowing said sample to react within at least one assay unit; and detecting said detectable signal generated from said analyte collected in said sample of bodily fluid. The bodily fluid sample can be blood and the method can comprise retrieving plasma from the blood.

[0021] In an ~~aspect~~example as provided herein, a method of on-demand assembly of a cartridge for automated detection of an analyte in a bodily fluid sample, wherein the device comprises a housing, said housing comprising: an array of addressable assay units, wherein an individual assay unit of the array is configured to run a chemical reaction that yields a detectable signal indicative of the presence or absence of the analyte; and an array of addressable reagent units, wherein an individual reagent unit of the array is addressed to correspond to the individual assay unit, said method comprises: (i) placing according to the analyte to be detected an array of addressable assay units, wherein an individual assay unit of the array is configured to run a chemical reaction that detects an analyte of interest ordered by said end user, into the housing; (ii) placing according to the analyte to be detected an array of reagent units, wherein an individual reagent unit of the array corresponds to the individual assay unit, into the housing; and (iii) securing the arrays of (i) and (ii) within the housing of the device. The method can comprise selecting an analyte to be detected. In some ~~embodiments~~examples, the method comprises sealing the cartridge. In an ~~embodiment~~example, the method comprises labeling the cartridge with a readable label indicating the analyte to be detected, for example with a bar code or RFID.

[0022] In an ~~aspect~~example, a method is provided for automated detection of a plurality of analytes in a bodily fluid sample, comprising: providing the bodily fluid sample to a fluidic device, wherein the fluidic device comprises: a sample collection unit configured to contain the bodily fluid sample; an array of assay units, wherein an individual assay unit of said array of assay units is configured to run a chemical reaction that yields a signal indicative of an individual analyte of said plurality of analytes being detected; and an array of reagent units, wherein an individual reagent unit of said array of reagent units contains a reagent; engaging the individual assay unit using a fluid transfer device; transferring the bodily fluid sample from the sample collection unit to the individual assay unit using the fluid transfer device; and transferring the reagent from the individual reagent unit to the individual assay unit,

thereby reacting the reagent with the bodily fluid sample to yield the signal indicative of the individual analyte of the plurality of analytes being detected.

[0023] In an ~~embodiment~~example, the fluid transfer device comprises a plurality of heads, wherein an individual head of the plurality of heads is configured to engage the individual assay unit; and wherein said fluid transfer device comprises a programmable processor configured to direct fluid transfer of the bodily fluid sample from the sample collection unit and the reagent from the individual reagent unit into the individual assay unit. The method can further comprise providing instructions to the programmable processor, wherein the instructions can direct the step of transferring the bodily fluid sample to the individual assay unit.

[0024] In an ~~embodiment~~example, the step of transferring the bodily fluid sample effects a degree of dilution of the bodily fluid sample in the individual assay unit to bring the signal indicative the individual analyte of the plurality of analytes being detected within a detectable range. The bodily fluid sample can comprise at least two individual analytes that are present at concentrations that differ by at least 2, 5, 10, 15, 50, or 100 orders of magnitude. In some instances, the degree of dilution of the bodily fluid sample brings the signals indicative of the at least two individual analytes within the detectable range. In an ~~embodiment~~example, the detectable range is about 1000 to about 1 million counts per second using a photomultiplier.

[0025] In an ~~embodiment~~example, the reagent in the individual reagent unit is an enzyme substrate for an immunoassay and the method can further comprise repeating the step of transferring the reagent from the individual reagent unit after the reaction to yield the signal indicative of the individual analyte of the plurality of analytes being detected is complete, thereby creating a second reaction to yield a second signal indicative of the individual analyte. An intensity of the signal and a second intensity of the second signal indicative of the individual analyte can be averaged to calculate the final intensity of the signal indicative of the individual analyte.

[0026] In an ~~aspect~~example, a method is described herein of measuring a volume of a liquid sample, comprising: reacting a known quantity of a control analyte in a liquid sample with a reagent to yield a detectable signal indicative of the control analyte; and comparing said detectable signal with an expected detectable signal, wherein the expected signal is indicative of an expected volume of the liquid sample, and wherein said comparison provides a measurement of said volume of said liquid sample being measured. In some instances, the control analyte is not normally present in said liquid sample in a detectable amount. The method can comprise verifying the volume of said liquid sample when the measurement of the volume of the sample is within about 50% of the expect volume of the liquid sample. In an ~~embodiment~~example, the method further comprises: reacting a bodily fluid sample containing a target analyte with a reagent to yield a detectable signal indicative of the target analyte; and measuring the quantity of the target analyte in the bodily fluid sample using an intensity of said detectable signal indicative of the target analyte and the measurement of said volume of said liquid sample. The liquid sample and the bodily fluid sample can be the same sample and the control analyte does not react with the target analyte in the bodily fluid sample. In some instances, the liquid sample and the bodily fluid sample are different liquid samples. The control analyte can be, for example, fluorescein-labeled albumin, fluorescein labeled IgG, anti-fluorescein, anti-digoxigenin, digoxigenin-labeled albumin, digoxigenin-labeled IgG, biotinylated proteins, non-human IgG.

[0027] In another ~~aspect~~example, a method of retrieving plasma from a blood sample is provided herein that comprises: mixing a blood sample in the presence of magnetizable particles in a sample collection unit, wherein the magnetizable particles comprise an antibody capture surface for binding to non-plasma portions of the blood sample; and applying a magnetic field above a plasma collection area to the mixed blood sample to effect suspension of the non-plasma portions of the blood sample on top of the plasma collection area. In some instances, the sample collection unit is a capillary tube. The blood sample can be less than about 20 microliters and the plasma

retrieved can be less than about 10 microliters. In some instances, the blood sample is not diluted. In some instance, mixing occurs in the presence of antibodies unbound to a solid surface. The mixing can comprise mixing by syringe action.

[0028] In yet another ~~aspect~~example, a method is provided herein of using automated immunoassay for detecting an analyte present in plasma portion of a whole blood sample, comprising: providing a whole blood sample to a device that is configured to automatically receive and process on board the whole blood sample to yield the plasma portion, from which a detectable signal indicative of the presence or absence of the analyte of interest is generated on board; detecting said signal that is indicative of the presence or absence of the analyte in said bodily fluid sample; and transmitting result of (b) to an end user. The immunoassay can be an ELISA. In some instances, the result is transmitted wirelessly.

[0029] In some ~~embodiments~~examples, a method as described herein is carried out in a system as described herein.

INCORPORATION BY REFERENCE

[0030] All publications and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Many novel features of the invention are set forth with particularity in the appended claims. A better understanding of the features and advantages of the invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which many principles of the invention are utilized, and the accompanying drawings of which:

[0032] Figure 1 illustrates an exemplary device of the invention comprising assay units, reagents unit, and other modular components of the device.

[0033] Figure 2 illustrates two side-cut away views of the exemplary device of Figure 1 comprising cavities in the housing of the device shaped to accommodate an assay unit, a reagent unit, and a sample tip.

[0034] Figure 3A demonstrates an exemplary assay unit that comprises a small tip or tubular formation.

[0035] Figure 3B demonstrates an example of a sample tip as described herein.

[0036] Figures 4A and 4B illustrate two examples of a reagent unit comprising a cup.

[0037] Figure 5 demonstrates an example of a system comprising a device and a fluid transfer device.

[0038] Figure 6 illustrates an exemplary system of the invention comprising a heating block for temperature control and a detector.

[0039] Figure 7 demonstrates an exemplary a system wherein a patient delivers blood to a device and then the device is inserted into a reader.

[0040] Figure 8 illustrates the process flow of building a system for assessing the medical condition of a patient.

[0041] Figures 9A through 9E demonstrate an example of a plasma separation method wherein a whole blood sample has been aspirated into a sample tip and a magnetic reagent is mixed and suspended with the sample, then a magnetic field is applied to the whole blood sample and magnetic reagent mixture. Separated blood plasma sample can then be distributed into a well of a device.

[0042] Figure 10 demonstrates an exemplary method of a control assay as described herein comprising a known quantity of control analyte.

[0043] Figure 11 illustrates a thin film, for example, contamination, within the tip when a liquid is expelled and another liquid aspirated.

CLAIMS

WHAT IS CLAIMED IS:

1. A cartridge for automated detection of an analyte in a bodily fluid sample comprising:

an array of addressable assay units configured to run a chemical reaction that yields a detectable signal indicative of the presence or absence of the analyte; and

an array of addressable reagent units, wherein an individual addressable reagent unit of the array is addressed to correspond to an individual addressable assay unit of the array of assay units, and wherein the individual reagent unit is configured to be calibrated in reference to the corresponding individual assay unit before the arrays are assembled on the cartridge.

2. A cartridge for automated detection of an analyte in a bodily fluid sample comprising:

a sample collection unit configured to receive the bodily fluid sample;

an array of assay units configured to receive a portion of the sample from the sample collection unit and run a chemical reaction that yields a detectable signal indicative of the presence of the analyte in the sample; and

an array of reagent units containing reagents for running the chemical reaction;

wherein an individual assay unit of the array of assay units and an individual reagent unit of the array of reagent units are configured to be movable into fluid communication such that reagents for running the chemical reaction are brought to contact with the portion of the sample in the assay unit.

3. The device of claim 1 further comprising a sample collection unit configured to receive the bodily fluid sample.
4. The device of claim 1 or 2, wherein the individual reagent unit is configured to receive a movable assay unit.
5. The device of claim 1 or 2, wherein the individual assay unit comprises an assay tip.
6. The device of claim 1 or 2, wherein the individual assay unit is configured to run an immunoassay.
7. The device of claim 1 or 2, wherein the bodily fluid sample is a blood sample.
8. The device of claim 2 or 3, wherein the sample collection unit is configured to receive a volume of the bodily fluid sample about 20 microliters or less.
9. The device of claim 2 or 3, wherein the sample collection unit is configured to receive a volume of the bodily fluid sample that is a single drop of blood.
10. The device of claim 1 or 2 further comprising a pretreatment unit configured to retrieve a portion of the bodily fluid sample for running the chemical reaction to detect the analyte.
11. The device of claim 10, wherein the bodily fluid is a whole blood sample and the portion is plasma.
12. A system for automated detection of an analyte in a bodily fluid sample comprising:
    a. a device of claim 1 or 2; and
    b. a detection assembly for detecting the detectable signal indicative of the presence or absence of the analyte.
13. The system of claim 12 further comprising a programmable mechanical device configured to move the individual assay unit from a first location to a second location.
14. The system of claim 12 further comprising a fluid transfer device.
15. The system of claim 14, wherein the fluid transfer device is a pipette.
16. The system of claim 14, wherein the fluid transfer device is automated.

17. The system of claim 12 further comprising a communication assembly for transmitting a protocol based on the analyte to be detected.
18. The system of claim 12 further comprising a heating block configured to receive the individual assay unit.
19. The system of claim 12 further comprising a magnetic block.
20. A system for automated detection of a plurality of analytes in a bodily fluid sample, comprising:

a fluidic device comprising:

a sample collection unit configured to contain the bodily fluid sample;

an array of assay units, wherein an individual assay unit of said array of assay units is configured to run a chemical reaction that yields a signal indicative of an individual analyte of said plurality of analytes being detected; and

an array of reagent units, wherein an individual reagent unit of said array of reagent units contains a reagent; and

a fluid transfer device comprising a plurality of heads, wherein an individual head of the plurality of heads is configured to engage the individual assay unit, and wherein said fluid transfer device comprises a programmable processor configured to direct fluid transfer of the bodily fluid sample from the sample collection unit and the reagent from the individual reagent unit into the individual assay unit.

21. The system of claim 20, wherein the configuration of the processor to direct fluid transfer effects a degree of dilution of the bodily fluid sample in the array of assay units to bring signals indicative of the plurality of analytes being detected within a detectable range, such that said plurality of analytes are detectable with said system.
22. The system of claim 21, wherein the bodily fluid sample comprises at least two analytes that are present at concentrations that differ by at least 2 orders of magnitude.
23. The system of claim 21, wherein the bodily fluid sample comprises at least two analytes that are present at concentrations that differ by at least 5 orders of magnitude.
24. The system of claim 22, wherein the degree of dilution of the bodily fluid sample brings the signals indicative of the at least two analytes within the detectable range.
25. The system of claim 21 further comprising a detector configured to detect signal intensities of the detectable range.
26. The system of claim 25, wherein the detector is a photomultiplier.
27. The system of claim 26, wherein the detectable range is about 1000 to about 1 million counts per second.
28. The system of claim 20, wherein the bodily fluid sample is less than about 20 ul.
29. The system of claim 20, wherein the bodily fluid sample is a single drop of blood.
30. The system of claim 20, wherein the individual head is configured to adhere to the individual assay unit.
31. The system of claim 20, wherein said individual assay unit provides an immunoassay reaction site.
32. The system of claim 20, wherein said individual assay unit is a pipette tip.
33. The system of claim 20, wherein the fluid transfer device is a pipette.
34. The system of claim 33, wherein the pipette is an air-displacement pipette.
35. The system of claim 20, wherein said fluid transfer device further comprises a motor in communication with the programmable processor.

36. The system of claim 35, wherein the motor moves said plurality of heads based on a protocol from said programmable processor, optionally wherein the programmable processor responds to a protocol transmitted from an external device.

37. A system for automated detection of an analyte in a plasma portion of a whole blood sample, comprising:

    a. a device configured to automatically receive and process the whole blood sample to yield the plasma portion, from which a detectable signal indicative of the presence or absence of the analyte of interest is generated onboard the device; and

    b. a detection assembly for detecting the detectable signal indicative of the presence or absence of the analyte.

38. A method of detecting an analyte in a bodily fluid sample comprising:

    a. providing a blood sample to the device of claim 1 or 2;

    b. allowing said sample to react within at least one assay unit; and

    c. detecting said detectable signal generated from said analyte collected in said sample of bodily fluid.

39. The method of claim 38, wherein the bodily fluid sample is blood and the method further comprises retrieving plasma from the blood.

40. A method of on-demand assembly of a cartridge for automated detection of an analyte in a bodily fluid sample, wherein the device comprises a housing, said housing comprising: an array of addressable assay units, wherein an individual assay unit of the array is configured to run a chemical reaction that yields a detectable signal indicative of the presence or absence of the analyte; and an array of addressable reagent units, wherein an individual reagent unit of the array is addressed to correspond to the individual assay unit, said method comprising:

    (i) placing according to the analyte to be detected an array of addressable assay units, wherein an individual assay unit of the array is configured to run a chemical reaction that detects an analyte of interest ordered by said end user, into the housing;

    (ii) placing according to the analyte to be detected an array of reagent units, wherein an individual reagent unit of the array corresponds to the individual assay unit, into the housing; and

    (iii) securing the arrays of (i) and (ii) within the housing of the device.

41. The method of claim 40 further comprising selecting an analyte to be detected.

42. The method of claim 40 further comprising sealing the cartridge.

43. The method of claim 40 further comprising labeling the cartridge with a readable label indicating the analyte to be detected.

44. The method of claim 43, wherein the readable label is a bar code or RFID.

45. A method for automated detection of a plurality of analytes in a bodily fluid sample, comprising:

    a. providing the bodily fluid sample to a fluidic device, wherein the fluidic device comprises: a sample collection unit configured to contain the bodily fluid sample; an array of assay units, wherein an individual assay unit of said array of assay units is configured to run a chemical reaction that yields a signal indicative of an individual analyte of said plurality of analytes being detected; and an array of reagent units, wherein an individual reagent unit of said array of reagent units contains a reagent;

    b. engaging the individual assay unit using a fluid transfer device;

c. transferring the bodily fluid sample from the sample collection unit to the individual assay unit using the fluid transfer device; and

d. transferring the reagent from the individual reagent unit to the individual assay unit, thereby reacting the reagent with the bodily fluid sample to yield the signal indicative of the individual analyte of the plurality of analytes being detected.

46. The method of claim 45, wherein the fluid transfer device comprises a plurality of heads, wherein an individual head of the plurality of heads is configured to engage the individual assay unit; and wherein said fluid transfer device comprises a programmable processor configured to direct fluid transfer of the bodily fluid sample from the sample collection unit and the reagent from the individual reagent unit into the individual assay unit.

47. The method of claim 46 further comprising providing instructions to the programmable processor.

48. The method of claim 47, wherein the instructions direct the step of transferring the bodily fluid sample to the individual assay unit.

49. The method of claim 45, wherein the step of transferring the bodily fluid sample effects a degree of dilution of the bodily fluid sample in the individual assay unit to bring the signal indicative the individual analyte of the plurality of analytes being detected within a detectable range.

50. The method of claim 45, wherein the bodily fluid sample comprises at least two individual analytes that are present at concentrations that differ by at least 2 orders of magnitude.

51. The method of claim 45, wherein the bodily fluid sample comprises at least two individual analytes that are present at concentrations that differ by at least 5 orders of magnitude.

52. The method of claim 50, wherein the degree of dilution of the bodily fluid sample brings the signals indicative of the at least two individual analytes within the detectable range.

53. The method of claim 45, wherein the detectable range is detected with a photomultiplier and is about 1000 to about 1 million counts per second.

54. The method of claim 45, wherein the bodily fluid sample is less than about 20 ul.

55. The method of claim 45, wherein the bodily fluid sample is a single drop of blood.

56. The method of claim 45, wherein the reagent in the individual reagent unit is an enzyme substrate for an immunoassay.

57. The method of claim 56 further comprising repeating the step of transferring the reagent from the individual reagent unit after the reaction to yield the signal indicative of the individual analyte of the plurality of analytes being detected is complete, thereby creating a second reaction to yield a second signal indicative of the individual analyte.

58. The method of claim 57, wherein an intensity of the signal and a second intensity of the second signal indicative of the individual analyte are averaged to calculate the final intensity of the signal indicative of the individual analyte.

59. A method of measuring a volume of a sample of a biological fluid, comprising:

a. reacting a known quantity of a control analyte in said sample with a reagent to yield a detectable signal indicative of the quantity of the control analyte; and

b. comparing said detectable signal with an expected detectable signal, wherein the expected signal is indicative of an expected volume of the sample, and wherein said comparison provides a measurement of said volume of said sample being measured.

60. The method of claim 59, wherein the control analyte is normally not present in said sample in a detectable amount.

61. The method of claim 59 further comprising verifying the volume of said sample when the measurement of the volume of the sample is within about 50% of the expected volume of the sample.

62. The method of claim 59 further comprising:

    a. reacting a bodily fluid sample containing a target analyte with a reagent to yield a detectable signal indicative of the target analyte; and

    b. measuring the quantity of the target analyte in the bodily fluid sample based on of said detectable signal indicative of the target analyte and the measurement of said volume of said liquid sample.

63. The method of claim 59, wherein the liquid sample and the bodily fluid sample are the same sample.

64. The method of claim 59, wherein the control analyte does not react with the target analyte in the bodily fluid sample.

65. The method of claim 59, wherein the liquid sample and the bodily fluid sample are different liquid samples.

66. The method of claim 59, wherein the control analyte is selected from the group consisting of: albumin, fluorescein, IgG, protein C, fluorescein-labeled albumin, fluorescein labeled IgG, anti-fluorescein, anti-digoxigenin, digoxigenin-labeled albumin, digoxigenin-labeled IgG, biotinylated proteins, and non-human IgG

67. The method of claim 59, wherein the method is carried out in a system of claim 12 or 19.

68. A method of retrieving plasma from a blood sample comprising:

    a. mixing a blood sample in the presence of magnetizable particles in a sample collection unit, wherein the magnetizable particles comprise an antibody capture surface for binding to non-plasma portions of the blood sample; and

    b. applying a magnetic field above a plasma collection area to the mixed blood sample to effect suspension of the non-plasma portions of the blood sample on top of the plasma collection area.

69. The method of claim 68, wherein the sample collection unit is a capillary tube.

70. The method of claim 68, wherein the blood sample is less than about 20 microliters.

71. The method of claim 68, wherein the plasma retrieved is less than about 10 microliters.

72. The method of claim 68, wherein the blood sample is not diluted.

73. The method of claim 68, wherein the mixing occurs in the presence of antibodies unbound to a solid surface.

74. The method of claim 68, wherein the mixing comprises mixing by syringe action.

75. The method of claim 68, wherein the method is carried out in a system of claim 12 or 19.

76. A method of using automated immunoassay for detecting an analyte present in plasma portion of a whole blood sample, comprising:

    a. providing a whole blood sample to a device that is configured to automatically receive and process on board the whole blood sample to yield the plasma portion, from which a detectable signal indicative of the presence or absence of the analyte of interest is generated on board;

    b. detecting said signal that is indicative of the presence or absence of the analyte in said bodily fluid sample; and

    c. transmitting result of (b) to an end user.

77. The method of claim 76, wherein the immunoassay is ELISA.

78. The method of claim 76, wherein the result is transmitted wirelessly.

CLAIMS

WHAT IS CLAIMED IS:

1. A method of retrieving plasma from a blood sample comprising:

a. mixing a blood sample in the presence of magnetizable particles in a sample collection unit, wherein the magnetizable particles comprise an antibody capture surface for binding to non-plasma portions of the blood sample; and

b. applying a magnetic field above a plasma collection area to the mixed blood sample to effect suspension of the non-plasma portions of the blood sample on top of the plasma collection area,

wherein said method is carried out in a system for automated detection of an analyte, said system comprising:

i) a cartridge for automated detection of an analyte, the cartridge comprising:

the sample collection unit, wherein the sample collection unit comprises the sample;

an array of assay units configured to receive a portion of the sample from the sample collection unit and run a chemical reaction that yields a detectable signal indicative of the presence of the analyte in the sample; and

an array of reagent units containing reagents for running the chemical reaction;

wherein an individual assay unit of the array of assay units and an individual reagent unit of the array of reagent units are configured to be movable into fluid communication such that reagents for running the chemical reaction are brought to contact with the portion of the sample in the assay unit; and

ii) a detection assembly for detecting the detectable signal indicative of the presence or absence of the analyte.

2. The method of claim 1, wherein the sample collection unit is a capillary tube.

3. The method of claim 1, wherein the blood sample is less than about 20 microliters.

4. The method of claim 1, wherein the plasma retrieved is less than about 10 microliters.

5. The method of claim 1, wherein the blood sample is not diluted.

6. The method of claim 1, wherein the mixing occurs in the presence of antibodies unbound to a solid surface.

7. The method of claim 1, wherein the mixing comprises mixing by syringe action.

8. The method of claim 1, wherein the magnetizable particles comprise an antibody to a red cell antigen or to an adaptor molecule.

9. The method of claim 8, wherein the adaptor molecule is biotin, digoxigenin, or fluorescein.

10. The method of claim 1, wherein 25% to 60% of the blood sample is plasma which can be separated.