presence or absence of a tubing segment in the space. For example, the first and second light emitters may be arranged with respect to each other and the optical sensor as described above, e.g., the first optical axis may pass through a center of a tubing segment in the space, the second optical axis may be offset from the tubing segment center, etc.

In an aspect of the invention, a peritoneal dialysis system may include at least one pump arranged to pump dialysate for delivery to a peritoneal cavity of a patient, and a patient line fluidly coupled to the at least one pump such that dialysate delivered from the pump is directed to the patient line. The patient line may have a distal end arranged for connection to a patient, e.g., for connection to a patient access to deliver dialysate to a peritoneal cavity of the patient. A patient line state detector may be arranged to be associated with the patient line and to detect both a presence of the patient line and a priming condition of the patient line, wherein the patient line state detector includes: a first light emitter having a first optical axis directed toward a space in which a portion of the patient line is to be positioned, the first light emitter positioned next to a side of the space at a predetermined point longitudinally along the space; a second light emitter having a second optical axis directed toward the space, the second light emitter being next to the first light emitter, and located at approximately the same point longitudinally along the space as the first light emitter; and an optical sensor positioned on a side of the space opposite the first and second light emitters and arranged to receive light emitted by the first and second light emitters to determine a presence or absence of the patient line in the space. For example, the patient line state detector may be arranged to receive the distal end of the patient line to detect the presence of the distal end and whether the distal end of the patient line is filled with fluid. This arrangement may be useful to allow the system and a patient to confirm that the patient line is sufficiently full of dialysate before connecting the patient line to the patient access connection.

The patient line state detector may include a cavity to receive the distal end of the patient line, one or more light emitters associated with the cavity arranged to direct light into the cavity, and one or more light detectors arranged to detect light emitted by the one or more light emitters. In one embodiment, a single light detector may be used to determine both the presence or absence of the patient line, as well as whether liquid is present in the patient line. The patient line state detector may be arranged in any of the ways that the tubing state detectors described above may be arranged. For example, first and second light emitters may be arranged adjacent each other and on a side of a cavity to receive the patient line that is opposite an optical sensor. A third light emitter may be arranged to have its optical axis arranged at an oblique angle to a sensor axis of the optical sensor, and thereby enable

detection of liquid in the patient line. Other features of the tubing state detectors described above may be incorporated into the patient line state detector, including the detection and use of relative light levels to indicate a presence of the patient line and/or liquid in the patient line, and so on.

In another aspect of the invention, a peritoneal dialysis system may include at least one pump arranged to pump dialysate for delivery to a peritoneal cavity of a patient; a patient line fluidly coupled to the at least one pump such that dialysate delivered from the pump is directed to the patient line; and a patient line state detector for detecting the presence or absence of a segment of the patient line. The patient line may have a distal end arranged for connection to a patient. The patient line state detector may comprise: a first light emitter having a first optical axis directed toward a space in which a patient line segment is to be positioned; a second light emitter having a second optical axis directed toward the space, the second light emitter being adjacent the first light emitter; a third light emitter having a third optical axis directed toward the space; and an optical sensor having a sensor optical axis positioned on a side of the space opposite the first and second light emitters and arranged to receive light emitted by the first and second light emitters to determine a presence or absence of a patient line segment in the space. The third optical axis may be arranged at an oblique angle relative to the sensor optical axis. The optical sensor and third light emitter may be arranged such that with a patient line segment in the space and the patient line segment may contain no liquid, a light level detected by the optical sensor is over a threshold level, and such that with a patient line segment in the space and the patient line segment containing liquid, a light level detected by the optical sensor is less than the threshold level.

In some examples of the invention, a method for detecting a presence of a tubing segment includes emitting first light along a first optical axis toward a space in which a tubing segment is to be optionally positioned, and emitting second light along a second optical axis toward the space, wherein the first and second light are emitted from a first side

Claims:

1. A peritoneal dialysis system, comprising:

at least one pump arranged to pump dialysate for delivery to a peritoneal cavity of a patient;

a patient line fluidly coupled to the at least one pump such that dialysate delivered from the pump is directed to the patient line, the patient line having a distal end arranged for connection to a patient; and

a patient line state detector arranged to be associated with the patient line and to detect both a presence of the patient line and a priming condition of the patient line, wherein the patient line state detector includes:

a first light emitter having a first optical axis directed toward a space in which a portion of the patient line is to be positioned, the first light emitter positioned next to a side of the space at a predetermined point longitudinally along the space;

a second light emitter having a second optical axis directed toward the space, the second light emitter being next to the first light emitter, and located at approximately the same point longitudinally along the space as the first light emitter; and

an optical sensor positioned on a side of the space opposite the first and second light emitters and arranged to receive light emitted by the first and second light emitters to determine a presence or absence of the patient line in the space.

2. The system of claim 1, wherein the patient line state detector is arranged to receive distal segment of the patient line to detect the presence of the distal segment and whether the distal segment of the patient line is filled with fluid.

3. The system of claim 2, wherein the patient line state detector includes:

a channel to receive the distal segment of the patient line, wherein:

the first and second light emitters are associated with the channel and arranged to direct light into the channel, the first and second light emitters positioned next to a side wall of the channel at the predetermined point longitudinally; and

the optical sensor is positioned on a side of the channel generally opposite the first and second light emitters.

4. The system of claim 1, wherein the second optical axis is approximately parallel to but spaced apart from the first optical axis.

5. The system of claim 1, wherein the optical sensor detects a higher or lower light level from the first light emitter when a portion of the patient line is in the space.

6. The system of claim 5, wherein the optical sensor detects a lower light level from the second light emitter when a portion of the patient line is in the space.

7. The system of claim 1, wherein with a portion of the patient line in the space, a detected light level for both the first and second light emitters differs by more than about 15-20% from a calibration light level for the first and second light emitters that is detected when a tubing segment is known to be absent from the space.

8. The system of claim 7, wherein with a portion of the patient line not in the space, a detected light level for the second light emitter is within about 15-20% of the calibration light level for the second light emitter.

9. The system of claim 1, wherein the optical sensor has an optical axis that is approximately collinear with the first optical axis.

10. The system of claim 1, wherein the first optical axis passes approximately through a center of a portion of the patient line with the portion of the patient line positioned in the space.

11. The system of claim 10, wherein the second optical axis is offset from a center of a portion of the patient line with the portion of the patient line positioned in the space.

12. The system of claim 1, wherein the optical sensor has a sensor optical axis, the detector further comprising a third light emitter having a third optical axis that is arranged at an oblique angle relative to the sensor optical axis.

13. The system of claim 12, wherein the oblique angle is about 110-120 degrees.

14. The system of claim 12, wherein the optical sensor and third light emitter are arranged such that with a portion of the patient line in the space and the portion of the patient line containing no liquid, a light level detected by the optical sensor is over about 150% of a calibration light level detected with no portion of the patient line in the space, and such that with a portion of the patient line in the space and the portion of the patient line containing liquid, a light level detected by the optical sensor is less than about 125% of the calibration light level.

15. The system of claim 12, wherein the optical sensor and third light emitter are arranged such that with a portion of the patient line in the space and the portion of the patient line containing no liquid, a light level detected by the optical sensor is over a threshold level, and such that with a portion of the patient line in the space and the portion of the patient line containing liquid, a light level detected by the optical sensor is less than the threshold level.

16. The system of claim 15, wherein the threshold level is about 125-150% of a light level detected by the optical sensor with no a portion of the patient line in the space.

17. The system of claim 1, wherein the portion of the patient line is a distal end of the patient line.

18. The system of claim 1, wherein the first and second light emitters are light emitting diodes.

19. The system of claim 1, wherein a portion of the patient line associated with the patient line state detector has a cylindrical outer surface and the patient line state detector is arranged to receive and hold the patient line without substantially deforming the patient line.

20. The system of claim 1, wherein the optical sensor is arranged to detect a presence of liquid in the patient line based on light from a third emitter that is sensed by the optical sensor.

21. A peritoneal dialysis system, comprising:

at least one pump arranged to pump dialysate for delivery to a peritoneal cavity of a patient;

a patient line fluidly coupled to the at least one pump such that dialysate delivered from the pump is directed to the patient line, the patient line having a distal end arranged for connection to a patient; and

a patient line state detector for detecting the presence or absence of a segment of the patient line, comprising:

a first light emitter having a first optical axis directed toward a space in which a patient line segment is to be positioned;

a second light emitter having a second optical axis directed toward the space, the second light emitter being adjacent the first light emitter;

a third light emitter having a third optical axis directed toward the space; and

an optical sensor having a sensor optical axis positioned on a side of the space opposite the first and second light emitters and arranged to receive light emitted by the first and second light emitters to determine a presence or absence of a patient line segment in the space, the third optical axis being arranged at an oblique angle relative to the sensor optical axis, wherein the optical sensor and third light emitter are arranged such that with a patient line segment in the space and the patient line segment containing no liquid, a light level detected by the optical sensor is over a threshold level, and such that with a patient line segment in the space and the patient line segment containing liquid, a light level detected by the optical sensor is less than the threshold level.

22. The system of claim 21, wherein the second optical axis is approximately parallel to the first optical axis.

23. The system of claim 21, wherein the optical sensor detects a higher or lower light level from the first light emitter when a patient line segment is in the space.

24. The system of claim 23, wherein the optical sensor detects a lower light level from the second light emitter when a patient line segment is in the space.

25. The system of claim 21, wherein with a patient line segment in the space, a detected light level for both the first and second light emitters differs by more than about 15-20% from a calibration light level for the first and second light emitters that is detected when a patient line segment is known to be absent from the space.

26. The system of claim 25, wherein with a patient line segment not in the space, a detected light level for the second light emitter is within about 15-20% of the calibration light level for the second light emitter.

27. The system of claim 21, wherein the optical sensor has an optical axis that is approximately collinear with the first optical axis.

28. The system of claim 21, wherein the first optical axis passes approximately through a center of a patient line segment with the patient line segment positioned in the space.

29. The system of claim 21, wherein the second optical axis is offset from a center of a patient line segment with the patient line segment positioned in the space.

30. The system of claim 21, wherein the oblique angle is about 110-120 degrees.

31. The system of claim 30, wherein the optical sensor and third light emitter are arranged such that with a patient line segment in the space and the patient line segment containing no liquid, a light level detected by the optical sensor is over about 150% of a calibration light level detected with no patient line segment in the space, and such that with a patient line segment in the space and the patient line segment containing liquid, a light level detected by the optical sensor is less than about 125% of the calibration light level.

32. The system of claim 21, wherein the threshold level is about 125-150% of a light level detected by the optical sensor with no patient line segment in the space.