Claims

1. An apparatus, comprising:

a catheter having a proximal end portion and a distal end portion and defining a lumen extending through the proximal end portion and the distal end portion;

an introducer having a proximal end portion and a distal end portion, the introducer defining an inner volume having a first portion and a second portion, the inner volume having a tortuous cross-sectional shape relative to a plane perpendicular to a longitudinal axis of the introducer such that an axis defined by the first portion of the inner volume is parallel to and offset from an axis defined by the second portion of the inner volume, the first portion being adjacent to a slot defined by the introducer, the second portion being offset from the first portion in a transverse direction along the plane, the second portion configured to movably receive the catheter, the distal end portion of the introducer configured to be coupled to an indwelling peripheral intravenous line; and

an actuator having a first portion extending through the slot to be movably disposed in the first portion of the inner volume and a second portion movably disposed in the second portion of the inner volume, the second portion of the actuator being coupled to the catheter, the actuator configured to move relative to the introducer to move the catheter between a first position and a second position, the catheter disposed within the introducer when in the first position, the distal end portion of the catheter disposed beyond the distal end portion of the introducer such that at least a portion of the catheter is disposed within the indwelling peripheral intravenous line when the catheter is in the second position and the introducer is coupled to the indwelling peripheral intravenous line.

2. The apparatus of claim 1, wherein the introducer includes a first member and a second member, the first member configured to couple to the second member to collectively form the introducer, an inner surface of the first member and an inner surface of the second member collectively defining the inner volume of the introducer when the first member is coupled to the second member.

3. The apparatus of claim 1, wherein the first portion of the actuator and the second portion of the actuator collectively have the tortuous cross-sectional shape.

4. The apparatus of claim 1, wherein the catheter is configured to reduce fluid flow restrictions present within the peripheral intravenous line as the catheter is moved from the first position to the second position, the distal end portion of the catheter being disposed within the peripheral intravenous line when the catheter is in the second position such that the distal end portion of the catheter is distal to a portion of the peripheral intravenous line otherwise restricted by the fluid flow restrictions.

5. The apparatus of claim 1, further comprising: a lock coupled to the distal end portion of the introducer, the lock configured to contact a portion of the peripheral intravenous line to couple the distal end portion of the introducer to the peripheral intravenous line, the lock defines a lumen, an axis defined by the lumen of the lock is substantially coaxial with the axis of the second portion of the inner volume, the lumen is configured to receive a portion of the catheter as the catheter is moved between the first position and the second position.

6. The apparatus of claim 1, further comprising:

an adapter disposed between the distal end portion of the introducer and the peripheral intravenous line, the adapter having an outer surface configured to be placed in contact with an inner surface of the peripheral intravenous line, the adapter having an inner surface defining a lumen, the lumen is configured to receive a portion of the catheter as the catheter is moved between the first position and the second position, the inner surface of the adapter is configured to guide the catheter as the catheter is moved between the first position and the second position.

7. The apparatus of claim 1, wherein the proximal end portion of the catheter is coupled to the actuator such that the distal end portion of the catheter is distal to actuator, the actuator is configured to couple to a distal end portion of a secondary catheter such that a proximal end portion of the secondary catheter is proximal to the actuator,

the secondary catheter defining a lumen in fluid communication with the lumen defined by the catheter, the proximal end portion of the secondary catheter is configured to fluidically couple to at least one of a fluid reservoir, a fluid source, or a syringe to place the lumen of the catheter in fluid communication with at least one of the fluid reservoir, the fluid source, or the syringe.

8. The apparatus of claim 7, wherein the proximal end portion of the introducer defines an

opening, the opening including a first portion having a first size and a second portion having a second size smaller than the first size,

a portion of the secondary catheter is movably disposed within the opening, the secondary catheter is configured to move between a first position, in which the secondary catheter is disposed in the first portion of the opening, and a second position, which the secondary catheter is disposed in the second portion of the opening, a surface of the introducer defining at least the second portion of the opening configured to contact the secondary catheter to substantially clamp the lumen of the secondary catheter when the secondary catheter is in the second position.

9. The apparatus of claim 1, wherein an inner surface of the introducer forming at least a portion of the tortuous cross-sectional shape of the inner volume is disposed in a line of sight defined between the slot and the second portion of the inner volume.

10. The apparatus of claim 1, wherein an inner surface of the introducer forming at least a portion of the tortuous cross-sectional shape of the inner volume is disposed in a line of sight defined between the slot and the catheter coupled to the second portion of the actuator.

11. The apparatus of claim 1, wherein the first portion of the actuator is configured to extend through the slot to be partially disposed outside of the inner volume.

12. The apparatus of claim 11, wherein an outer surface of the introducer forms a plurality of ribs, each rib from the plurality of ribs being distributed along a length of the introducer, the first portion of the actuator including a tab configured to move along the plurality of ribs when the actuator is moved relative to the introducer.

13. An apparatus, comprising:

a catheter having a proximal end portion and a distal end portion and defining a lumen extending through the proximal end portion and the distal end portion;

an introducer having a proximal end portion and a distal end portion, the introducer defining an inner volume having a first portion and a second portion, the first portion being adjacent to a slot defined by the introducer, the second portion configured to movably receive the catheter, the inner volume having a tortuous cross-sectional shape relative to a plane perpendicular to a longitudinal axis of the introducer such that an axis

defined by the first portion is parallel to and offset from an axis defined by the second portion, the second portion being offset from the first portion in a transverse direction along the plane such that an inner surface of the introducer defining at least a portion of the tortuous cross-sectional shape of the inner volume is disposed in a line of sight defined between the slot and the catheter disposed in the second portion of the inner volume;

an actuator having a first portion and a second portion, the first portion of the actuator disposed outside of the inner volume defined by the introducer and in contact with an outer surface of the introducer, the second portion of the actuator disposed within the inner volume defined by the introducer and coupled to the catheter, the actuator configured to move relative to the introducer to move the catheter between a first position and a second position; and

a lock coupled to the distal end portion of the introducer, the lock having a proboscis and defining a lumen extending through the proboscis, the lock configured to couple the introducer to an indwelling peripheral intravenous line, the proboscis configured to extend through a lumen defined by the indwelling peripheral intravenous line when the lock couples the introducer thereto, the lumen of the proboscis configured to receive a portion of the catheter as the catheter is moved from the first position, in which the catheter is disposed within the inner volume of the introducer, to the second position, in which the distal end portion of the catheter extends beyond the indwelling peripheral intravenous line when the lock couples the introducer thereto, an inner surface of the proboscis configured to guide the catheter as the catheter is moved from the first position to the second position.

14. The apparatus of claim 13, wherein the distal end portion of the introducer includes a seal configured to transition from a closed configuration to an open configuration in response to a change in pressure within the inner volume, the seal being in the closed configuration when the catheter is in the first position.

15. The apparatus of claim 13, wherein the lock includes a seal disposed in the lumen defined by the proboscis, the seal being in a closed configuration and the catheter being disposed in a proximal position relative to the seal when the catheter is in the first position.

16. The apparatus of claim 13, wherein a proximal end portion of the peripheral intravenous line is coupled to an adapter, the adapter defines a lumen and includes a seal disposed in the lumen,

the lock is configured to be coupled to the adapter to couple the introducer to the peripheral intravenous line, a portion of the proboscis is disposed in the lumen defined by the adapter and is configured to transition the seal from a closed configuration to an open configuration when the lock is coupled to the adapter.

17. The apparatus of claim 13, wherein the proboscis has an outer surface defining an outer diameter of the proboscis, the outer surface of the proboscis configured to selectively contact an inner surface defining at least a portion of the lumen of the peripheral intravenous line to support at least a portion the peripheral intravenous line.

18. The apparatus of claim 13, wherein the lock includes a first arm disposed on a first side of the proboscis and a second arm disposed on a second side of the proboscis opposite the first side of the proboscis, the first arm and the second arm are configured to pivot relative to the proboscis in response to a force exerted on the first arm and the second arm, respectively.

19. The apparatus of claim 13, wherein the lock includes a first arm disposed on a first side of the proboscis and a second arm disposed on a second side of the proboscis opposite the first side of the proboscis, a portion of the first arm and a portion of the second arm are each configured to deform when the lock is coupled to the peripheral intravenous line.

20. The apparatus of claim 13, wherein the lock includes a first arm disposed on a first side of the proboscis, the first arm includes a tab, the lock includes a second arm disposed on a second side of the proboscis opposite the first side of the proboscis, the second arm includes a tab, the tab of the first arm and the tab of the second arm are each configured to engage the peripheral intravenous line to couple the lock to the peripheral intravenous line.

21. The apparatus of claim 20, wherein the proboscis has an outer surface defining an outer diameter of the proboscis, the outer surface of the proboscis configured to selectively contact an inner surface defining at least a portion of the lumen of the peripheral intravenous line when the proboscis is disposed within the lumen defined by the peripheral intravenous line,

the tab of the first arm of the lock, the tab of the second arm of the lock, and the outer surface of the proboscis establishing at least three points of physical contact operable to couple the lock to the peripheral intravenous line.

22. The apparatus of claim 13, wherein the peripheral intravenous line is a first peripheral intravenous line having a first configuration, the lock is configured to couple to at least one of the first peripheral intravenous line or a second peripheral intravenous line disposed in a portion of a patient, the second peripheral intravenous line having a second configuration different from the first configuration,

the lock configured to couple to at least one of the first peripheral intravenous line or the second peripheral intravenous line such that the lock can be rotated 360 degrees relative to the first peripheral intravenous line or the second peripheral intravenous line.

23. An apparatus, comprising:

a catheter having a proximal end portion and a distal end portion and defining a lumen extending through the proximal end portion and the distal end portion;

an introducer having a first member and a second member coupled to the first member, the second member having an outer surface forming a plurality of ribs, the first member and the second member collectively defining an inner volume and a slot in communication with the inner volume, the inner volume including a first portion adjacent to the slot and a second portion configured to receive the catheter, the inner volume having a tortuous cross-sectional shape relative to a plane perpendicular to a longitudinal axis of the introducer, the second portion being offset from the first portion in a transverse direction along the plane such that a surface of the first member is disposed in a line of sight defined between the slot and the catheter disposed in the second portion, a distal end portion of the introducer configured to be coupled to an indwelling peripheral intravenous line; and

an actuator having a first portion and a second portion, the actuator operatively coupled to the introducer, the first portion of the actuator disposed outside of the inner volume, the first portion including a surface in contact with the outer surface of the second member, the second portion of the actuator extending through the slot and disposed within the inner volume, the second portion of the actuator being coupled to the catheter, the actuator configured to move relative to the introducer to move the catheter between a first position, in which the catheter is disposed within the introducer, and a second position, in which the distal end portion of the catheter is disposed beyond at least a portion of the indwelling peripheral intravenous line when the introducer is coupled to the indwelling peripheral intravenous line, the surface of the first portion of the actuator configured to move along the plurality of ribs as the actuator moves the catheter between the first position and the second position, the surface of the actuator and the plurality of ribs providing a haptic output

to a user associated with a position of the distal end portion of the catheter.

24. The apparatus of claim 23, wherein at least a portion of the catheter is formed of a flexible braided material.

25. The apparatus of claim 23, wherein the haptic output produced in response to the surface of the actuator being moved along the plurality of ribs is a vibration of at least in portion of the actuator.

26. The apparatus of claim 23, wherein an inner surface of the first member and an inner surface of the second member collectively define the inner volume of the introducer.

27. The apparatus of claim 26, wherein the inner surface of the first member obstructs the line of sight between the slot and the catheter disposed within the second portion of the inner volume.

28. The apparatus of claim 23, wherein the plurality of ribs formed by the second member includes a first plurality of ribs and a second plurality of ribs, each rib from the first plurality of ribs has a first size, each rib from the second plurality of ribs has a second size different from the first size.

29. The apparatus of claim 28, wherein the surface of the first portion of the actuator is configured to move along the first plurality of ribs with a first set of characteristics, the surface of the first portion of the actuator is configured to move along the second plurality of ribs with a second set of characteristics different from the first set of characteristics.

30. The apparatus of claim 28, wherein the surface of the actuator and each rib from the first plurality of ribs collectively produce a first haptic output as the surface of the actuator is moved relative to each rib from the first plurality of ribs, the surface of the actuator and each rib from the second plurality of ribs collectively produce a second haptic output as the surface of the actuator is moved relative to each rib from the second plurality of ribs, the second haptic output is different from the first haptic output.

31. The apparatus of claim 28, wherein the first plurality of ribs are uniformly distributed

along a first length of the second member, the second plurality of ribs are uniformly distributed along a second length of the second member, the first length of the second member being proximal to the second length of the second member.

32. The apparatus of claim 31, wherein the first size is smaller than the second size.

33. The apparatus of claim 31, wherein the plurality of ribs includes the first plurality of ribs, the second plurality of ribs, and a third plurality of ribs, the third plurality of ribs are uniformly distributed along a third length of the second member, the third length of the second member being distal to the second length of the second member.

34. The apparatus of claim 23, wherein a size of each rib from the plurality of ribs can increase with each successive rib from the plurality of ribs from a first size of a proximal most rib from the plurality of ribs to a second size of a distal most rib from the plurality of ribs.

35. The apparatus of claim 23, wherein the plurality of ribs is a first plurality of ribs, the first member of the introducer has an outer surface forming a second plurality of ribs, a local maxima of each rib from the first plurality of ribs being offset from a local maxima of each rib from the second plurality of ribs, a local minima of each rib from the first plurality of ribs being offset from a local minima of each rib from the second plurality of ribs.

36. The apparatus of claim 23, wherein each rib from the plurality of ribs has an asymmetric shape, the surface of the first portion of the actuator is configured to move in the distal direction along the plurality of ribs with a first set of characteristics, the surface of the first portion of the actuator is configured to move in the proximal direction along the plurality of ribs with a second set of characteristics different from the first set of characteristics.

37. An apparatus, comprising:

a catheter having a proximal end portion and a distal end portion and defining a lumen extending through the proximal end portion and the distal end portion;

an introducer having a first member and a second member coupled to the first member, the first member having an outer surface forming a first plurality of ribs and the second member having an outer surface forming a second plurality of ribs, a local maxima of

each rib from the first plurality of ribs being offset from a local maxima of each rib from the second plurality of ribs, a local minima of each rib from the first plurality of ribs being offset from a local minima of each rib from the second plurality of ribs, the first member and the second member collectively defining an inner volume and a slot in communication with the inner volume, the inner volume configured to receive the catheter, a distal end portion of the introducer configured to be coupled to an indwelling peripheral intravenous line; and

an actuator having a first portion and a second portion, the actuator operatively coupled to the introducer, the first portion of the actuator disposed outside of the inner volume, the first portion including a surface in contact with the outer surface of the second member, the second portion of the actuator extending through the slot and disposed within the inner volume, the second portion of the actuator being coupled to the catheter, the actuator configured to move relative to the introducer to move the catheter between a first position, in which the catheter is disposed within the introducer, and a second position, in which the distal end portion of the catheter is disposed beyond at least a portion of the peripheral intravenous line when the introducer is coupled to the peripheral intravenous line, the surface of the first portion of the actuator configured to move along the plurality of ribs as the actuator moves the catheter between the first position and the second position, the surface of the actuator and the plurality of ribs providing a haptic output to a user associated with a position of the distal end portion of the catheter.