

WHAT IS CLAIMED IS:

1. A medical device comprising:
a catheter assembly, the catheter assembly including a catheter adapter subassembly
5 and a needle subassembly,
wherein one of the catheter adapter subassembly and the needle subassembly includes a
permanent magnet element, and the other of the catheter subassembly and the needle
subassembly includes a magnetizable feature.
- 10 2. The medical device according to claim 1, wherein the needle subassembly includes the
magnetizable feature and the catheter adapter subassembly includes the permanent magnet
element, and the magnetizable feature of the needle subassembly is selected from the group
consisting of a needle adhesive, the needle, a needle safety element, a notch, a needle ferrule,
and a spot weld.
- 15 3. The medical device according to claim 1, wherein at least one of the permanent magnet
element and magnetizable feature includes an adhesive.
4. The medical device according to claim 3, wherein the catheter adapter subassembly
20 includes catheter tubing and a catheter adapter body, and the adhesive attaches the catheter
tubing to the catheter adapter body.
5. The medical device according to claim 3, wherein the needle subassembly includes a
cannula and a hub, and the adhesive attaches the cannula to the hub.
- 25 6. The medical device according to claim 1, wherein the needle subassembly includes the
magnetizable feature, a cannula and a hub, and the catheter adapter subassembly includes a
catheter adapter body, catheter tubing and the permanent magnet element, wherein the
permanent magnet element is selected from the group consisting of a metal mandrel for
30 connecting catheter tubing to the hub, a catheter tubing adhesive, a blood control component of
the catheter adapter subassembly, and a magnetic wedge on the catheter adapter body.

7. The medical device according to claim 6, wherein the magnet element on the catheter adapter body is integrally molded with the catheter adapter body.
8. The medical device according to claim 1, wherein the catheter adapter subassembly includes the permanent magnet element and the needle subassembly includes the magnetizable feature and the magnetizable feature is a magnetizable needle.
9. The medical device according to claim 3, wherein the adhesive includes an additive selected from a paramagnetic additive, a ferromagnetic additive and combinations thereof.
10. The medical device according to claim 9, wherein the additive includes a component selected from the group consisting of powdered iron, magnetic iron oxide, magnetic titanium oxide, magnetic powdered steel, and a magnetic iron alloy, and mixtures thereof.
11. The medical device according to claim 10, wherein the magnetic iron alloy includes one or more of nickel, zinc, and copper.
12. The medical device according to claim 10, wherein the additive further comprises a component selected from chromium, magnesium, molybdenum and combinations thereof.
13. The medical device according to claim 1, wherein the needle subassembly includes the permanent magnet element, and the catheter adapter subassembly includes the magnetizable feature, wherein the magnetizable feature includes magnetizable catheter tubing.
14. The medical device according to claim 1, wherein needle subassembly includes a cannula, the catheter adapter subassembly includes a catheter adapter body, catheter tubing and the permanent magnet element, and the permanent magnet element has north and south poles on axis with the catheter tubing and with the cannula.
15. The medical device according to claim 1, wherein the needle subassembly includes a cannula and the permanent magnet element, the catheter adapter subassembly includes a catheter adapter body and catheter tubing, and wherein the permanent magnet element has north and south poles on axis with the catheter tubing and with the cannula.

16. A system for determining relative position of a catheter adapter subassembly and a needle subassembly comprising:
- a catheter having a catheter distal tip and a needle having a needle distal tip;
 - a permanent magnet element associated with one of the catheter adapter subassembly and
5 needle subassembly;
 - a magnetizable feature associated with the other of the catheter adapter subassembly and the needle subassembly; and
 - magnetometers positioned with respect to the catheter adapter subassembly and the needle subassembly, the magnetometers configured to determine relative movement of the catheter
10 adapter subassembly and needle subassembly.
17. The system of claim 16, wherein the permanent magnet element or the magnetizable feature on a fixed location on the catheter adapter subassembly or needle subassembly provides a measurement datum to determine movement of the magnetizable feature and permanent
15 magnet.
18. The system of claim 17, wherein the magnetometers include three different magnetometers arranged in a three-dimensional grid array as part of an ultrasound system which can derive a three-dimensional correlation to obtain a distance from the grid array to the
20 magnetizable feature or permanent magnet.
19. The system of claim 18, wherein the three-dimensional correlation is determined by a function $I = f(B_i \mu_r)$, where $i = x$ or y or z along three axes, x , y and z are distances in three planes, B is a known magnetic field produced by the permanent magnet or magnetizable
25 feature, and μ_r is magnetic permeability.
20. The system of claim 18, wherein the correlation provides a distance in three planes to determine location of the catheter distal tip or the needle distal tip.
- 30 21. A method for determining a relative position of a catheter tip and a needle cannula tip, the method comprising:

providing a catheter adapter subassembly including catheter and a needle subassembly including a needle, the catheter having a catheter distal tip and the needle having a needle distal tip;
associating a permanent magnet element with one of the catheter and the needle;
5 associating a magnetizable feature with the other of the catheter and the needle;
obtaining a measured position of the permanent magnet;
obtaining a measured position of the magnetizable feature to obtain a calculated position of the catheter distal tip and a calculated position of the needle distal tip; and
10 comparing the calculated position of the catheter distal tip with the calculated position of the needle distal tip to determine the relative position of the catheter distal tip and the needle distal tip.

22. The method of claim 21, wherein the needle includes the magnetizable feature and the catheter includes the permanent magnet and the relative position of the catheter distal tip and the needle distal tip indicates that the catheter is properly seated on the needle, for example,
15 wherein the relative position of the catheter distal tip and the needle distal tip indicates that the catheter is in a hooded position on the needle or the relative position of the catheter distal tip and the needle distal tip indicates that the catheter distal tip is advanced a specific distance or angle.

20 23. The method of claim 21, wherein the catheter adapter subassembly includes the magnetizable feature and the needle subassembly includes the permanent magnet, and relative movement of the catheter adapter subassembly and needle subassembly is determined by a three-dimensional array of magnetometers positioned in proximity to at least one of the
25 permanent magnet the magnetizable feature.

24. The method of claim 21, wherein the catheter adapter subassembly includes the permanent magnet and the needle subassembly includes the magnetizable feature, and relative movement of the catheter adapter subassembly and needle subassembly is determined by a
30 three-dimensional array of magnetometers positioned in proximity to at least one of the permanent magnet the magnetizable feature.

25. The method of claim 23 or 24, further comprising magnetizing the magnetizable feature by applying an external magnetic field to the magnetizable feature.
26. The method of claim 23 or 24, wherein the three-dimensional array of magnetometers
5 is part of an ultrasound system, and the ultrasound system derives a three-dimensional correlation to obtain a distance from the array of magnetometers to the magnetizable feature or permanent magnet.
27. The method of claim 26, wherein the three-dimensional correlation is determined by
10 the function $I = f(B_i \mu_r)$, where $i = x$ or y or z along three axes, x , y and z are distances in three planes, B is a known magnetic field produced by the permanent magnet or magnetizable feature, and μ_r is magnetic permeability.
28. A catheter adapter subassembly comprising a magnetic feature selected from the group
15 consisting of a metal mandrel for connecting catheter tubing to a catheter hub, a catheter tubing adhesive, a blood control component of the catheter adapter subassembly, and a magnetic wedge on a catheter adapter body.
29. The catheter adapter subassembly according to claim 28, further comprising magnetic
20 catheter tubing.
30. The catheter adapter subassembly according to claim 28, wherein the metal mandrel comprises austenitic stainless steel.