

TUBULAR INSTRUMENT AND RELATED DEVICES AND METHODS

BACKGROUND

[0001] A catheter is commonly used to infuse fluids into vasculature of a patient. For example, the catheter may be used for infusing normal saline solution, various medicaments, or total parenteral nutrition. The catheter may also be used for withdrawing blood from the patient.

[0002] The catheter may include an over-the-needle peripheral intravenous (“IV”) catheter. In this case, the catheter may be mounted over an introducer needle having a sharp distal tip. The catheter and the introducer needle may be assembled so that the distal tip of the introducer needle extends beyond the distal tip of the catheter with the bevel of the needle facing up away from skin of the patient. The catheter and introducer needle are generally inserted at a shallow angle through the skin into vasculature of the patient.

[0003] In order to verify proper placement of the introducer needle and/or the catheter in the blood vessel, a clinician generally confirms that there is “flashback” of blood in a flashback chamber of the catheter assembly. Once placement of the needle has been confirmed, the clinician may temporarily occlude flow in the vasculature and remove the needle, leaving the catheter in place for future blood withdrawal or fluid infusion.

[0004] Blood withdrawal using the catheter may be difficult for several reasons, particularly when a dwell time of the catheter within the vasculature is more than one day. When the catheter is left inserted in the patient for a prolonged period of time, the catheter or vein may be more susceptible to narrowing, collapse, kinking, blockage by debris (e.g., fibrin or platelet clots), and adhering of a tip of the catheter to the vasculature. Due to this, the catheter is often used for acquiring a blood sample at a time of catheter placement, but the catheter is less frequently used for acquiring a blood sample during the catheter dwell period. Therefore, when a blood sample is

required, an additional needle stick is often needed to provide vein access for blood collection, which may be painful for the patient and result in higher material costs.

[0005] In some instances, in order to avoid the additional needle stick, a tubular instrument may be used to access the vasculature of the patient via the catheter. The tubular instrument may be inserted through the catheter and into the vasculature to extend a life of the catheter and allow blood withdrawal through the catheter without the additional needle stick. Generally the tubular instrument has a high stiffness and a thin wall. The high stiffness allows advancement of the tubular instrument without buckling, and the thin wall facilitates increased flow rates through the tubular instrument. However, the high stiffness in combination with the thin wall results in a sharp, stiff distal edge of the tubular instrument, which can induce trauma to the vein wall. In particular, as the tubular instrument is advanced distally beyond a distal tip of the catheter, the tubular instrument may damage a vein wall and increase a risk of thrombus and other complications.

[0006] The subject matter claimed herein is not limited to embodiments that solve any disadvantages or that operate only in environments such as those described above. Rather, this background is only provided to illustrate one example technology area where some implementations described herein may be practiced.

SUMMARY

[0007] The present disclosure relates generally to vascular access devices. In particular, the present disclosure relates to a tubular instrument and related devices and methods. In some embodiments, a delivery device to deliver a tubular instrument into a catheter may facilitate an increased dwell period of the catheter. In further detail, the delivery device may be used to advance

the tubular instrument into the catheter and/or beyond a distal tip of the catheter for fluid infusion or blood draw when the catheter is compromised or nearing an end of its life.

[0008] In some embodiments, the delivery device may include the tubular instrument, which may include axial structural stiffness to facilitate advancement of the tubular instrument without buckling. In some embodiments, the tubular instrument may also have an inner diameter to facilitate high flow rates for fluid infusion and/or blood draw. While providing axial structural stiffness and high flow rates, unlike tubular instruments in the prior art, the tubular instrument may also provide gentle, soft contact between the tubular instrument and a vein wall, which may reduce trauma to the vein wall. In some embodiments, the tubular instrument may also sustain flexural bending. In some embodiments, advantages of the tubular instrument may result from a multi-material structure.

[0009] In some embodiments, the tubular instrument may include an annular wall. In some embodiments, the annular wall may include a distal end and a proximal end. In some embodiments, the annular wall may form a lumen, which may extend through the distal end of the annular wall and/or the proximal end of the annular wall. In some embodiments, the tubular instrument may include a distal opening, which may be disposed within the distal end of the annular wall.

[0010] In some embodiments, the tubular instrument may include one or more stripes, which may be disposed within the annular wall. In some embodiments, the stripes may extend proximally from the distal end of the annular wall. In some embodiments, the stripes may be aligned with a longitudinal axis of the tubular instrument. In some embodiments, the stripes may extend proximally from the distal opening. In some embodiments, the stripes may extend proximally from a position proximal to the distal opening.

[0011] In some embodiments, an outer perimeter of each of the stripes may be surrounded by the annular wall. In some embodiments, the stripes may be co-extruded within the annular wall. In some embodiments, the stripes may be constructed of a first material, and the annular wall may be constructed of a second material. In some embodiments, the first material may have a greater durometer than the second material. Thus, in some embodiments, the stripes may be stiffer than the annular wall.

[0012] In some embodiments, the first material may include thermoplastic elastomer, thermoplastic polyurethane, polyurethane, nylon, polyimide, silicon, or another suitable polymer. In some embodiments, the first material may include metal. In some embodiments, each of the stripes may include a wire, which may be constructed of metal. In some embodiments, the wire may be configured to hold the tubular instrument in a curved position in response to the wire being bent. In some embodiments, the second material may include polypropylene, polyurethane, polyurethane, nylon, polyimide, silicon, or another suitable polymer. In some embodiments, the second material may be similar to the first material but lower density.

[0013] In some embodiments, the stripes may provide stiffness to the tubular instrument, which may facilitate advancement of the tubular instrument through a catheter assembly and beyond the distal tip of the catheter without buckling. In some embodiments, the second material may be disposed on the outer surface of the tubular instrument, which may provide a softer contact surface with the vein.

[0014] In some embodiments, the annular wall may include an inner surface and an outer surface. In some embodiments, the inner surface may be proximate the lumen of the tubular instrument. In some embodiments, the inner surface may be cylindrical and/or the stripes may protrude to form ribs on the outer surface. In some embodiments, other than the ribs on the outer

surface formed by the stripes, the outer surface may be cylindrical. In some embodiments, the outer surface may be cylindrical and/or the stripes may protrude to form ribs on the inner surface. In some embodiments, other than the ribs on the other surface formed by the stripes, the outer surface may be cylindrical. In some embodiments, other than the ribs on the inner surface formed by the stripes, the inner surface may be cylindrical.

[0015] In some embodiments, the stripes may be closer to the inner surface than the outer surface. In some embodiments, the stripes may be closer to the outer surface than the inner surface. In some embodiments, the stripes may be spaced around the annular wall. In some embodiments, the stripes may be evenly spaced around the annular wall.

[0016] In some embodiments, the annular wall may include a first annular section and a second annular section distal to the first annular section. In some embodiments, a durometer of the first annular section may be greater than a durometer of the second annular section. In some embodiments, the second annular section may include the distal opening.

[0017] In some embodiments, the first annular section may be constructed of the first material. In some embodiments, the second annular section may be constructed of the second material. In some embodiments, a durometer of the first material may be greater than a durometer of the second material. In some embodiments, a thickness of the first annular section may be greater than a thickness of the second annular section. In some embodiments, an outer surface of the second annular section may include multiple grooves, which may extend perpendicular to a longitudinal axis of the tubular instrument.

[0018] In some embodiments, the first annular section may include one or more stripes, which may be co-extruded within the first annular section. In some embodiments, the stripes may be aligned with the longitudinal axis of the tubular instrument. In some embodiments, the stripes may

be constructed of the first material. In some embodiments, the second annular section may be constructed of the second material. In some embodiments, the first material may have a greater durometer than the second material.

[0019] In some embodiments, the annular wall may include a third annular section between the first annular section and the second annular section. In some embodiments, the third annular section may be proximate the first annular section and/or the second annular section. In some embodiments, the first annular section may be proximate the second annular section.

[0020] In some embodiments, the distal end of the annular wall may include a first annular layer and a second annular layer. In some embodiments, the first annular layer may be disposed within the second annular layer. In some embodiments, the second annular layer may surround the first annular layer. In some embodiments, the first annular layer may be constructed of the first material. In some embodiments, the second annular layer may be constructed of the second material. In some embodiments, the first material may have a greater durometer than the second material.

[0021] In some embodiments, the distal end of the annular wall may include a third annular layer, which may be disposed within the first annular layer and the second annular layer. In some embodiments, the first annular layer may surround the third annular layer. In some embodiments, the third annular layer may be constructed of the second material or a third material. In some embodiments, the first material may have a greater durometer than the third material.

[0022] In some embodiments, a thickness of the second annular layer may be greater than a thickness of the first annular layer at a first position along a length of the tubular instrument. In some embodiments, the thickness of the second annular layer may be a same thickness as the thickness of the first annular layer at a second position along the length of the tubular instrument.

In some embodiments, the second position may be proximal to the first position. In some embodiments, the thickness of the second annular layer may be less than the thickness of the first annular layer at a third position along the length of the tubular instrument. In some embodiments, the third position may be proximal to the second position.

[0023] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention, as claimed. It should be understood that the various embodiments are not limited to the arrangements and instrumentality shown in the drawings. It should also be understood that the embodiments may be combined, or that other embodiments may be utilized and that structural changes, unless so claimed, may be made without departing from the scope of the various embodiments of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0024] Example embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

[0025] Figure 1 is an upper perspective view of an example tubular instrument, according to some embodiments;

[0026] Figure 2A is a transverse cross-sectional view of the tubular instrument of Figure 1 along the line 2-2 of Figure 1, according to some embodiments;

[0027] Figure 2B is another transverse cross-sectional view of the tubular instrument of Figure 1 along the line 2-2 of Figure 1, according to some embodiments;

[0028] Figure 2C is another transverse cross-sectional view of the tubular instrument of Figure 1 along the line 2-2 of Figure 1, according to some embodiments;

[0029] Figure 2D is another transverse cross-sectional view of the tubular instrument of Figure 1 along the line 2-2 of Figure 1, according to some embodiments;

[0030] Figure 2E is another transverse cross-sectional view of the tubular instrument of Figure 1 along the line 2-2 of Figure 1, according to some embodiments;

[0031] Figure 2F is another transverse cross-sectional view of the tubular instrument of Figure 1 along the line 2-2 of Figure 1, according to some embodiments;

[0032] Figure 3A is an upper perspective view of an example tubular instrument, according to some embodiments;

[0033] Figure 3B is a transverse cross-sectional view of the tubular instrument of Figure 3A along the line 3B-3B of Figure 3A, according to some embodiments;

[0034] Figure 3C is a transverse cross-sectional view of the tubular instrument of Figure 3A along the line 3C-3C of Figure 3A, according to some embodiments;

[0035] Figure 3D is a transverse cross-sectional view of the tubular instrument of Figure 3A along the line 3D-3D of Figure 3A, according to some embodiments;

[0036] Figure 4A is a longitudinal cross-sectional view of a portion of another example tubular instrument, according to some embodiments;

[0037] Figure 4B is a transverse cross-sectional view of the tubular instrument of Figure 4A, according to some embodiments;

[0038] Figure 5A is an upper perspective view of another tubular instrument, according to some embodiments;

[0039] Figure 5B is a transverse cross-sectional view of the tubular instrument of Figure 5A along the line 5B-5B of Figure 5A, according to some embodiments;

[0040] Figure 6 is an upper perspective view of another example tubular instrument, according to some embodiments;

[0041] Figure 7 is an upper perspective view of an example delivery device, according to some embodiments;

[0042] Figure 8A is an upper perspective view of another example delivery device coupled to an example catheter assembly, according to some embodiments;

[0043] Figure 8B is a cross-sectional view of the delivery device of Figure 8A, according to some embodiments; and

[0044] Figure 8C a cross-sectional view of the catheter assembly of Figure 8A, illustrating an example tubular instrument in an advanced or distal position, according to some embodiments.

DESCRIPTION OF EMBODIMENTS

[0045] Referring now to Figure 1, in some embodiments, a delivery device to deliver a tubular instrument 10 into a catheter may facilitate an increased dwell period of the catheter. In further detail, the delivery device may be used to advance the tubular instrument 10 into the catheter and/or beyond a distal tip of the catheter for fluid infusion or blood draw when the catheter is compromised or nearing an end of its life. In some embodiments, the tubular instrument 10 may include axial structural stiffness to facilitate advancement of the tubular instrument 10 without buckling. In some embodiments, the tubular instrument 10 may also have an inner diameter to facilitate high flow rates for fluid infusion and/or blood draw. While providing axial structural stiffness and high flow rates, unlike the tubular instrument of the prior art, the tubular instrument 10 may also provide gentle, soft contact between the tubular instrument 10 and a vein wall, which may reduce trauma to the vein wall. In some embodiments, the tubular instrument 10 may also sustain flexural bending.

[0046] In some embodiments, the tubular instrument 10 may include an annular wall 12. In some embodiments, the annular wall 12 may include a distal end 14 and a proximal end 16. In some embodiments, the annular wall 12 may form a lumen 18, which may extend through the distal end 14 of the annular wall 12 and/or the proximal end 16 of the annular wall 12. In some embodiments, the tubular instrument 10 may include a distal opening 20, which may be disposed within the distal end 14 of the annular wall 12.

[0047] In some embodiments, the distal opening 20 may be aligned with a longitudinal axis 22 of the tubular instrument 10. In other embodiments, a portion of the distal end 14 aligned with the longitudinal axis 22 may be closed, and the distal opening 20 may be disposed lateral to the longitudinal axis 22 through the annular wall 12. In some embodiments, the distal end 14 may include one or more diffusion holes (not illustrated), which may extend through the annular wall 12. In some embodiments, the diffusion holes may be disposed proximal to the distal opening 20. In some embodiments, the distal end 14 may be blunt, tapered, or another suitable shape.

[0048] Referring now to Figure 2A-2F, in some embodiments, the tubular instrument 10 may include one or more stripes 24, which may be disposed within the annular wall 12. In some embodiments, the stripes 24 may include long narrow bands or strips. In some embodiments, each of the stripes 24 may have a uniform or variable diameter along a length of the stripe 24. In some embodiments, the stripes 24 may allow the annular wall 12 to be thin for a high flow rate through the tubular instrument 10, without increasing a sharpness of the distal end 14 and a risk of trauma to the vein.

[0049] In some embodiments, the stripes 24 may extend along all or a portion of a length of the annular wall 12 between the distal end 14 and the proximal end 16. In some embodiments, the stripes 24 may extend proximally from the distal end 14 of the annular wall 12. In some

embodiments, a distal-most portion of each of the stripes 24 may be spaced apart from a distal-most surface of the distal end 14. In these embodiments, the stripes 24 may extend proximally from a position near the distal opening 20 but proximal to the distal opening within the distal end 14, which may increase a softness of a distal-most portion of the distal end 14, which may contact the vein wall of a patient. In these embodiments, the annular wall 12 may encapsulate or completely surround the stripes 24. In some embodiments, the stripes 24 may extend proximally from the distal opening 20 and/or the distal-most surface of the distal end 14. In some embodiments, the stripes 24 may be aligned or generally aligned with the longitudinal axis 22 of the tubular instrument 10.

[0050] In some embodiments, a number of the stripes 24 may vary. In some embodiments, between one and three stripes 24 may be disposed within the annular wall 12. In some embodiments, more than three stripes 24 may be disposed within the annular wall 12. As illustrated in Figure 2A, in some embodiments, the tubular instrument 10 may include four stripes 24. In some embodiments, the stripes 24 may be spaced around the annular wall 12. In some embodiments, the stripes 24 may be evenly spaced around the annular wall 12, as illustrated, for example, in Figure 2A. In some embodiments, an outer perimeter of each of the stripes 24 may be surrounded by the annular wall 12 along all or a portion of its length, as illustrated, for example, in Figure 2A.

[0051] In some embodiments, the stripes 24 may be co-extruded within the annular wall 12. In some embodiments, the stripes 24 may be constructed of a first material, and the annular wall 12 may be constructed of a second material. In some embodiments, the first material may have a greater durometer than the second material. Thus, in some embodiments, the stripes 24 may be stiffer than the annular wall 12.

[0052] In some embodiments, the first material may be thermoplastic. In some embodiments, the first material may include an elastomer, polyurethane, polyurethane, nylon, polyimide, silicon, or another suitable polymer. In some embodiments, the first material may include metal. In some embodiments, each of the stripes 24 may include a wire, which may be constructed of metal. In some embodiments, the wire may be configured to hold the tubular instrument 10 in a curved position in response to the wire being bent, which may position the tubular instrument 10 away from the vein wall or valve and into a center of the vein.

[0053] In some embodiments, the second material may be thermoplastic. In some embodiments, the second material may include polypropylene, polyurethane, polyurethane, nylon, polyimide, silicon, or another suitable polymer. In some embodiments, the second material may be similar to the first material but lower density.

[0054] In some embodiments, the stripes 24 may provide stiffness to the tubular instrument 10, which may facilitate advancement of the tubular instrument 10 through a catheter assembly and beyond the distal tip of the catheter without buckling. In some embodiments, the second material may be disposed on all or a portion of the outer surface and outer circumference of the tubular instrument 10, which may provide a softer contact surface with the vasculature.

[0055] In some embodiments, the annular wall 12 may include an inner surface 30 and an outer surface 32. In some embodiments, the inner surface 30 may be proximate the lumen 18 of the tubular instrument 10. In some embodiments, the inner surface 30 may be cylindrical and/or the stripes 24 may protrude to form ribs 34 on the outer surface 32. In some embodiments, other than the ribs 34 on the outer surface 32 formed by the stripes 24, the outer surface 32 may be cylindrical.

[0056] In some embodiments, the outer surface 32 may be cylindrical and/or the stripes 24 may protrude to form the ribs 34 on the inner surface 30, as illustrated, for example, in Figures 2B-2C.

In some embodiments, other than the ribs 34 on the inner surface 30 formed by the stripes 24, the inner surface 30 may be cylindrical. In some embodiments, the tubular instrument 10 may include no more than one stripe 24, as illustrated, for example, in Figure 2C. In some embodiments, the ribs 34 may reduce contact between the annular wall 12 and the vein wall. In some embodiments, the stripes 24 may extend through the annular wall 12, as illustrated, for example, in Figure 2D.

[0057] As illustrated, for example, in Figure 2E, in some embodiments, the distal end 14 of the annular wall 12 may include a first annular layer 36 and a second annular layer 38. In some embodiments, the first annular layer 36 may be disposed within the second annular layer 38. In some embodiments, the second annular layer 38 may surround the first annular layer 36. In some embodiments, the first annular layer 36 may be constructed of the first material. In some embodiments, the second annular layer 38 may be constructed of the second material. In some embodiments, the first material may have a greater durometer than the second material.

[0058] In some embodiments, the first annular layer 36 and the second annular layer 38 may be concentrically co-extruded. In some embodiments, the first annular layer 36 may have a uniform or variable thickness along a length of the first annular layer 36. In some embodiments, the second annular layer 38 may have a uniform or variable thickness along a length of the second annular layer 38.

[0059] In some embodiments, the first annular layer 36 and/or the second annular layer 38 may extend along all or a portion of a length of the annular wall 12 between the distal end 14 and the proximal end 16. In some embodiments, the first annular layer 36 and/or the second annular layer 38 may extend proximally from the distal end 14 of the annular wall 12. In some embodiments, a distal-most portion of each of the first annular layer 36 may be spaced apart from a distal-most surface of the distal end 14. In these embodiments, the first annular layer 36 may extend proximally

from a position near the distal opening 20 but proximal to the distal opening within the distal end 14, which may increase a softness of a distal-most portion of the distal end 14, which may contact the vein wall of a patient. In some embodiments, the first annular layer 36 and/or the second annular layer 38 may extend proximally from the distal opening 20 and/or the distal-most surface of the distal end 14.

[0060] As illustrated, for example, in Figure 2F, in some embodiments, the distal end 14 of the annular wall 12 may include a third annular layer 40, which may be disposed within the first annular layer 36 and the second annular layer 38. In some embodiments, the first annular layer 36 may surround and be proximate the third annular layer 40. In some embodiments, the third annular layer 40 may be constructed of the second material or a third material. In some embodiments, the first material may have a greater durometer than the third material. In some embodiments, the first annular layer 36, the second annular layer 38, and the third annular layer 40 may be concentrically co-extruded.

[0061] Referring now to Figures 3A-3D, the tubular instrument 10 is illustrated, according to some embodiments. In some embodiments, the first annular layer 36 and/or the second annular layer 38 may have a variable thickness along a length of the tubular instrument 10. In some embodiments, a stiffness of the tubular instrument 10 may progressively increase in a proximal direction. Thus, the distal end 14 may be stiffer than the proximal end 16, which may facilitate gentle, soft contact between the distal end 14 and the vein wall, while also preventing buckling.

[0062] As illustrated, for example, in Figure 3B, a thickness of the second annular layer 38 may be greater than a thickness of the first annular layer 36 at a first position along a length of the tubular instrument 10. As illustrated, for example, in Figure 3C, the thickness of the second annular layer 38 may be a same thickness as the thickness of the first annular layer 36 at a second position

along the length of the tubular instrument 10. In some embodiments, the second position may be proximal to the first position. As illustrated, for example, in Figure 3D, the thickness of the second annular layer 38 may be less than the thickness of the first annular layer 36 at a third position along the length of the tubular instrument. In some embodiments, the third position may be proximal to the second position.

[0063] Referring now to Figures 4A-4B, in some embodiments, a distal-most portion of each of the stripes 24 may be spaced apart from a distal-most surface of the distal end 14. In these and other embodiments, the inner surface 30 may be cylindrical and/or the stripes 24 may protrude to form ribs 34 on the outer surface 32. In some embodiments, other than the ribs 34 on the outer surface 32 formed by the stripes 24, the outer surface 32 may be cylindrical. In some embodiments, a portion of the tubular instrument 10 that includes the stripes 24 may have a greater outer diameter than a portion of the tubular instrument 10 without the stripes 24, such as a portion of the tubular instrument 10 proximate the distal-most surface of the distal end 14.

[0064] Referring now to Figures 5A-5B, in some embodiments, an outer surface of the distal end 14 of the tubular instrument 10 may include multiple grooves 42, which may improve a flexibility of the distal end 14. In some embodiments, the grooves 42 may include arc-shaped slots. In some embodiments, the grooves 42 may extend around a portion of an outer circumference of the distal end 14. In some embodiments, the tubular instrument 10 may be formed with a single or multiple material extrusion. In some embodiments, the tubular instrument 10 may be constructed of a single material, such as the first material, along an entire length of the tubular instrument 10 between the distal end 14 and the proximal end 16.

[0065] Referring now to Figure 6, in some embodiments, the annular wall 12 may include a first annular section 44 and a second annular section 46 distal to the first annular section 44. In

some embodiments, the first annular section 44 may be constructed of the first material. In some embodiments, the second annular section 46 may be constructed of the second material. In some embodiments, the durometer of the first material and the first annular section 34 may be greater than the durometer of the second material and the second annular section 46.

[0066] In some embodiments, the second annular section 46 may be disposed at a distal-most portion of the distal end 14, which may provide gentle, soft contact between the tubular instrument 10 and the vein wall. In some embodiments, the second annular section 46 may include the distal opening 20. In some embodiments, a thickness of the first annular section 44 may be greater than a thickness of the second annular section 46, which may provide an increased stiffness or durometer of the first annular section 44 compared to the second annular section 46.

[0067] In some embodiments, the first annular section 44 may include one or more of the stripes 24 (see, for example, Figures 2A-2D), which may be co-extruded within the first annular section 44. In some embodiments, the stripes 24 may be aligned with the longitudinal axis of the tubular instrument 10. In some embodiments, the stripes 24 may be constructed of the first material. In some embodiments, second annular section 46 and/or the annular wall 12 of the first annular section 44 may be constructed of the second material.

[0068] In some embodiments, the first annular section 44 may be proximate the second annular section 46 and there may be an abrupt change between the first annular section 44 and the second annular section 46, such as via bonding or another suitable method. In these embodiments, the first annular section 44 and the second annular section 46 may be joined together without a third annular section 48. In some embodiments, the first annular section 44 and the second annular section 46 may be a continuous structure or formed via a continuous extrusion.

[0069] In some embodiments, the annular wall 12 may include the third annular section 48 between the first annular section 44 and the second annular section 46. In some embodiments, the third annular section 48 may be proximate the first annular section 44 and the second annular section 46. In some embodiments, one or more of the first annular section 44, the second annular section 46, and the third annular section 48 may extend from an outer surface of the tubular instrument 10 inwardly to the lumen 18.

[0070] In some embodiments, the third annular section 48 may transition from the first annular section 44 to the second annular section 46. In some embodiments, the third annular section 48 may include a durometer in between the durometer of the first annular section 44 and the second annular section 46. In some embodiments, the third annular section 48 may include a joint that joins the first annular section 44 to the second annular section 46. In some embodiments, the joint may be formed via a solvent, adhesive bonding, swaging, ultrasound welding, tipping, or another suitable method.

[0071] In some embodiments, the tubular instrument 10 may be coupled to any suitable delivery device. In some embodiments, the catheter of the catheter assembly may include one or more features of one or more of the tubular instruments 10 described with respect to Figures 1-6. Figures 7-9 illustrate several non-limiting examples of delivery devices. In some embodiments, the delivery device may be further described in U.S. Patent Application No. 16/037,246, filed July 17, 2018, entitled "EXTENSION HOUSING A PROBE OR INTRAVENOUS CATHETER," U.S. Patent Application No. 16/388,650, filed April 18, 2019, entitled "INSTRUMENT DELIVERY DEVICE HAVING A ROTARY ELEMENT," U.S. Patent Application No. 16/037,319, filed July 17, 2018, entitled "MULTI-DIAMETER CATHETER AND RELATED DEVICES AND METHODS," U.S. Patent Application No. 16/502,541, filed

July 3, 2019, entitled “DELIVERY DEVICE FOR A VASCULAR ACCESS INSTRUMENT,” U.S. Patent Application No. 16/691,217, filed November 21, 2019, entitled “SYRINGE-BASED DELIVERY DEVICE FOR A VASCULAR ACCESS INSTRUMENT,” U.S. Patent Application No. 16/742,013, filed January 14, 2020, entitled “CATHETER DELIVERY DEVICE AND RELATED SYSTEMS AND METHODS,” and U.S. Patent Application No. 16/838,831, filed April 2, 2020, entitled “VASCULAR ACCESS INSTRUMENT HAVING A FLUID PERMEABLE STRUCTURE AND RELATED DEVICES AND METHODS,” which are incorporated by reference in their entirety.

[0072] Referring now to Figure 7, in some embodiments, the delivery device 50 may deliver the tubular instrument 10 into a catheter of a catheter assembly, such as, for example, the catheter assembly 64 of Figures 8A and 8C. A catheter assembly 64 is illustrated in Figures 8A and 8C, according to some embodiments. In some embodiments, the delivery device 50 may include an extension, which may be proximate and/or coupled to a proximal end of a catheter adapter of the catheter assembly. In some embodiments, the extension may include an adapter 52, which may be coupled to the proximal end of the tubular instrument 10. In some embodiments, the adapter 52 may correspond to the Becton Dickinson VACUTAINER® one-use holder or a similar holder.

[0073] In some embodiments, the adapter 52 may be configured to move along a slot 54 in a housing 56 from a proximal position to a distal position and/or from the distal position to the proximal position. In some embodiments, in response to movement of the adapter 52 along the slot 54 from the proximal position to the distal position, the tubular instrument 10 may be advanced beyond the distal end of the housing 56. In some embodiments, in response to movement of the adapter 52 along the slot 54 from the distal position to the proximal position, the tubular instrument 10 may be withdrawn into the housing 56.

[0074] In some embodiments, the extension may include an advancement tab 58, which may be coupled to the proximal end of the tubular instrument 10 and/or the adapter 52. In some embodiments, the clinician may pinch or grasp the advancement tab 58 to move the tubular instrument 10 to the proximal position and/or the distal position. In some embodiments, the tubular instrument 10 may be advanced beyond the distal end of the housing 56 when the adapter 52 is disposed in the distal position. In some embodiments, the advancement tab 58 may be disposed in any number of locations.

[0075] In some embodiments, the distal end of the housing 56 may include a coupling mechanism 60, which may couple the delivery device 50 with the catheter assembly. In some embodiments, the coupling mechanism 60 may include a luer fitting.

[0076] Referring now to Figures 8A-8C, a delivery device 62 may be coupled to the catheter assembly 64. In some embodiments, the catheter assembly 64 may include the catheter adapter 66 and the catheter 68, which may extend distally from the catheter adapter 66. In some embodiments, the catheter 68 may be secured within the catheter adapter 66. In some embodiments, the catheter 68 may include a peripheral intravenous catheter (“PIVC”), peripherally inserted central catheter (“PICC”) or a midline catheter.

[0077] In some embodiments, the delivery device 62 may be directly coupled to a proximal end of the catheter adapter 66. In these and other embodiments, the catheter assembly 64 may include a straight or non-integrated catheter assembly. In some embodiments, the delivery device 62 may be coupled to an extension set 70 of the catheter assembly 64 as illustrated in FIG. 8A. In these and other embodiments, the catheter assembly 64 may include an integrated catheter assembly. In further detail, in some embodiments, the catheter adapter 66 of the catheter assembly 64 may include an integrated extension tube, such as, for example, the BD NEXIVA™ Closed IV Catheter

System, the BD NEXIVA™ DIFFUSICS™ Closed IV Catheter System, or the BD PEGASUS™ Safety Closed IV Catheter System.

[0078] In some embodiments, the delivery device 62 may include a rotary element 72 and a housing 74. In some embodiments, in response to rotation of the rotary element 72 with respect to the housing 74 in a first direction, the distal end 14 of the tubular instrument 10 may be advanced beyond a distal end 76 of the catheter 68. In some embodiments, in response to rotation of the rotary element 72 with respect to the housing 74 in the first direction, the distal end 14 of the tubular instrument 10 may be disposed at a first location with respect to the catheter assembly 64. An example first location is illustrated in Figure 8B.

[0079] In some embodiments, in response to rotation of the rotary element 72 with respect to the housing 74 further in the first direction, the distal end 14 of the tubular instrument 10 may be disposed at a second location with respect to the catheter assembly 64. In some embodiments, the second location may be distal to the first location. An example second location is illustrated in FIG. 8C. In some embodiments, the tubular instrument 10 may be continuously advanced in the distal direction as the rotary element 28 is continuously turned.

[0080] In some embodiments, in response to rotation of the rotary element 72 with respect to the housing 74 in the first direction, the distal end 14 of the tubular instrument 10 may be disposed a first amount beyond the distal end 76 of the catheter 68. In some embodiments, in response to rotation of the rotary element 72 with respect to the housing 74 further in the first direction, the distal end 14 of the tubular instrument 10 may be disposed a second amount beyond the distal end 76 of the catheter 68. In some embodiments, the second amount may be greater than the first amount.

[0081] In some embodiments, the rotary element 72 may also rotate with respect to the housing 74 in a second direction opposite to the first direction. In some embodiments, in response to rotation of the rotary element 72 with respect to the housing 74 in the second direction, the distal end 14 of the tubular instrument 10 may be moved proximally.

[0082] In some embodiments, the rotary element 72 may include a support surface or groove 78, which may extend around at least a portion of a circumference of the rotary element 72. In some embodiments, the groove 78 may include a width approximately equal to or slightly greater than the tubular instrument 10, which may facilitate support of the tubular instrument 10.

[0083] All examples and conditional language recited herein are intended for pedagogical objects to aid the reader in understanding the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Although embodiments of the present inventions have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

CLAIMS

1. A delivery device to deliver a tubular instrument into a catheter, the delivery device comprising:
the tubular instrument, comprising:
 - an annular wall comprising a distal end and forming a lumen;
 - a distal opening within the distal end of the annular wall;
 - a stripe within the annular wall and extending proximally from the distal end of the annular wall, wherein the stripe is co-extruded within the annular wall, wherein the stripe is constructed of a first material, wherein the annular wall is constructed of a second material, wherein the first material has a greater durometer than the second material.
2. The delivery device of claim 1, wherein the stripe is aligned with a longitudinal axis of the tubular instrument.
3. The delivery device of claim 1, wherein an outer perimeter of the stripe is surrounded by the annular wall.
4. The delivery device of claim 3, wherein the annular wall comprises an inner surface and an outer surface, wherein the stripe protrude to form a rib on the outer surface.
5. The delivery device of claim 3, wherein the annular wall comprises an inner surface and an outer surface, wherein the stripe protrudes to form a rib on the inner surface.
6. The delivery device of claim 1, further comprising a plurality of stripes, wherein the stripe is one of a plurality of stripes, wherein the plurality of stripes are evenly spaced around the annular wall.

7. The delivery device of claim 1, wherein the stripe extends proximally from the distal opening.
8. The delivery device of claim 1, wherein the stripe extends proximally from a position proximal to the distal opening.
9. The delivery device of claim 1, wherein the stripe comprises a wire configured to hold the tubular instrument in a curved position.
10. A delivery device to deliver a tubular instrument into a catheter, the delivery device comprising:
the tubular instrument, comprising:
an annular wall comprising a distal end and forming a lumen, wherein the annular wall comprises a first annular section and a second annular section distal to the first annular section, wherein a durometer of the first annular section is greater than a durometer of the second annular section;
a distal opening within the distal end of the annular wall, wherein the second annular section comprises the distal opening.
11. The delivery device of claim 10, wherein the first annular section is constructed of a first material, wherein the second annular section is constructed of a second material, wherein a durometer of the first material is greater than a durometer of the second material.
12. The delivery device of claim 10, wherein a thickness of the first annular section is greater than a thickness of the second annular section.
13. The delivery device of claim 10, wherein the first annular section comprises a stripe co-extruded within the first annular section, wherein the stripe is aligned with a longitudinal axis of the tubular instrument, wherein the stripe is constructed of a first material,

wherein the second annular section is constructed of a second material, wherein the first material has a greater durometer than the second material.

14. The delivery device of claim 10, wherein the annular wall comprises a third annular section between the first annular section and the second annular section, wherein the third annular section is proximate the first annular section and the second annular section.
15. The delivery device of claim 10, wherein the first annular section is proximate the second annular section.
16. The delivery device of claim 10, wherein an outer surface of the second annular section comprises a plurality of arc-shaped grooves.
17. A delivery device to deliver a tubular instrument into a catheter, the delivery device comprising:
the tubular instrument, comprising:

an annular wall comprising a distal end and forming a lumen, wherein the distal end of the annular wall comprises a first annular layer and a second annular layer, wherein the first annular layer is disposed within the second annular layer, wherein the first annular layer is constructed of a first material, wherein the second annular layer is constructed of a second material, wherein the first material has a greater durometer than the second material; and

a distal opening within the distal end of the annular wall.

18. The delivery device of claim 17, wherein the distal end of the annular wall comprises a third annular layer disposed within the first annular layer and the second annular layer, wherein the third annular layer is constructed of the second material or a third material, wherein the first material has a greater durometer than the third material.

19. The delivery device of claim 17, wherein a thickness of the second annular layer is greater than a thickness of the first annular layer at a first position along a length of the tubular instrument, wherein the thickness of the second annular layer is the same as the thickness of the first annular layer at a second position along the length of the tubular instrument, wherein the second position is proximal to the first position.
20. The delivery device of claim 19, wherein the thickness of the second annular layer is less than the thickness of the first annular layer at a third position along the length of the tubular instrument, wherein the third position is proximal to the second position.