

1 LARYNGOSCOPE INSERTION SECTION

2
3 Field of the invention

4
5 The invention relates to the field of laryngoscope insertion sections which include a tube
6 guide for detachably retaining an endotracheal tube and guiding a retained endotracheal tube
7 towards a patient's larynx.

8
9 Background to the invention

10
11 Laryngoscopes comprise insertion sections, which are the elongate part of a laryngoscope
12 which extends towards and into a patient's oral cavity during intubation. Insertion sections
13 may be removably attachable to a laryngoscope body, integral parts of laryngoscopes or
14 themselves function as laryngoscopes. As well as an insertion section, laryngoscopes
15 typically comprises a handle which is usually elongate and which may be arranged at an
16 angle to the proximal end of the insertion section or generally parallel to the proximal end of
17 the insertion section, or at any angle therebetween.

18
19 Some known laryngoscope insertion sections, such as Miller or Wisconsin insertion sections,
20 are substantially flat. However, the insertion section of a laryngoscope is more commonly
21 bent to better enter through a patient's oropharynx towards their larynx. Some known
22 insertion sections include first and second straight portions, with a bend therebetween, or are
23 curved, at least in part. Within this specification and the appended claims, the inferior
24 surface is the surface of an insertion section which faces the patient's tongue in use. The

opposite surface is referred to as the superior surface. Words such as inferior, inferiorly, superior and superiorly are used in corresponding senses. A superior-inferior axis is a virtual axis extending parallel to the superior and inferior directions.

The words distal and distally refer to being towards the end of the insertion section which extends towards a patient's trachea in use and the words proximal and proximally refer to being towards the person carrying out intubation in use.

It is known to provide a laryngoscope insertion section including a tube guide which extends along the length of the insertion section. For example, WO 04/073510 (Gandarias) discloses a laryngoscope insertion section including a tube guide which extends laterally from an elongate member which contains apparatus to provide an image of a patient's larynx in use. The tube guide has inferior and superior walls which extend continuously along the length of the tube guide. An endotracheal tube may be fitted into the tube guide and the insertion of the endotracheal tube into a patient's larynx can be viewed by a user. The endotracheal tube can then be detached from the insertion section whilst the insertion section remains within a patient and the insertion section can be removed, leaving the endotracheal tube in place.

Tube guides can facilitate intubation by ensuring that, once an insertion section is in place and the patient's larynx sighted, an endotracheal tube is already in the correct location to be pushed forward and inserted into a patient's larynx. However, a potential disadvantage is that tube guides increase the bulk of the insertion section. Accordingly, the present invention aims to provide an insertion section with a tube guide in which the insertion section is adapted to reduce its bulk, to facilitate introduction of the insertion section into a patient with an endotracheal tube in place within the tube guide.

Another problem with known insertion sections with tube guides is that they are typically designed for use with endotracheal tubes of a limited range of sizes. Some aspects of the present invention are directed to providing insertion sections adapted to guide a wider operating range of endotracheal tube sizes than known insertion sections with tube guides.

Furthermore, the laryngoscope disclosed in WO 04/073510 has a generally J-shaped insertion section which retains an endotracheal tube in a generally J-shaped configuration. This has two significant disadvantages. Firstly, the insertion of a J-shaped insertion section into a patient's oral cavity can be difficult. A J-shaped insertion section must be tilted backwards and forwards during insertion to insert the distal end, manipulate the patient's anatomy and obtain a good view of the patient's larynx. It is preferable to provide a

laryngoscope which can be more readily inserted. Secondly, this arrangement means that, when the endotracheal tube is pushed forward to advance the tube, a resistive force is developed on the superior side of the tube guide where the endotracheal tube bends from being substantially straight to curved, which increases friction. Some embodiments of the present invention aim to provide an insertion section which is easier to insert into a patient and/or which has a tube guide along which an endotracheal tube can be more readily advanced.

Some aspects of the present invention aim to provide an insertion section having a tube guide which is easier to operate, for example because less force is required, than with known insertion sections with tube guides, or to provide improved adjustability.

Summary of the invention

According to a first aspect of the present invention there is provided an elongate laryngoscope insertion section having a proximal end and a distal end for insertion into a patient's oral cavity in use, the insertion section comprising a tube guide for removably retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's larynx, the tube guide comprising a plurality of tube guiding members having tube guiding surfaces which are arranged to contact and thereby guide the inferior or superior surface of a retained endotracheal tube, the plurality of tube guiding members comprising at least an inferior tube guiding member having a tube guiding surface on a superior side thereof for contacting and thereby guiding the inferior surface of a retained endotracheal tube, and a first superior tube guiding member having a tube guiding surface on an inferior side thereof for contacting and thereby guiding the superior surface of a retained endotracheal tube, wherein the insertion section comprises a first region, which is proximal of the tube guiding surface of the first superior tube guiding member, where the thickness of the insertion section is less than the sum of the external diameter of the largest external diameter endotracheal tube in an operating range of endotracheal tube sizes plus the mean thickness of the inferior tube guiding member plus the mean thickness of the first superior tube guiding member.

Accordingly, at least in the first region, the insertion section is narrower than would be the case if it had tube guiding walls which extended both inferiorly and superiorly of a retained endotracheal tube in use, which walls ran continuously along the length of the insertion section.

1 By the thickness of an insertion section, we refer to the displacement, parallel to a superior-
2 inferior axis, from the most inferior point on the inferior side of the insertion section to the
3 most superior point on the superior side of the insertion section, through a given cross-
4 section orthogonal to the length of the insertion section. Words such as "thick", "thicker",
5 "narrow", and "narrower" should be construed accordingly.

6
7 By the mean thickness of a tube guiding member we refer to the mean distance from the
8 inferior side to the superior side where the tube guiding surface of the tube guiding member is
9 most inferior or most superior, as appropriate, along the length of the tube guiding surface of
10 the tube guiding member. We do not intend that the thickness of any parts of tube guiding
11 members which do not contact and thereby guide the inferior or superior surface of retained
12 endotracheal tubes are taken into account when assessing the mean thickness of a tube
13 guiding member as any such part is not subject to the same strength requirements as the
14 parts which contact and thereby guide the inferior or superior surface of retained
15 endotracheal tubes and it is these strength requirements which typically determine the
16 minimum thickness of a tube guiding member. The tube guiding surfaces of the or each
17 superior tube guiding member may extend along the length of, or along part of the length of,
18 the or each superior tube guiding member. The tube guiding surface of the inferior tube
19 guiding member may extend along the length of, or part of the length of, the inferior tube
20 guiding member.

21
22 Preferably, the insertion section is configured such that, in the first region, the combined
23 thickness of the insertion section and a retained endotracheal tube having the largest
24 external diameter in the operating range of endotracheal tube sizes, is less than the sum of
25 the external diameter of the largest external diameter endotracheal tube in the operating
26 range of endotracheal tube sizes plus the mean thickness of the inferior tube guiding member
27 plus the mean thickness of the first superior tube guiding member.

28
29 At least a part of, and optionally all of, the tube guiding surface of the first superior tube
30 guiding member may be opposite at least a part of the tube guiding surface of the inferior
31 tube guiding member. Alternatively, the tube guiding surface of the first superior tube guiding
32 member and the tube guiding surface of the inferior tube guiding member may not be
33 opposite each other.

34
35 By providing an elongate laryngoscope insertion section having a first region which has a
36 thickness that is less than the sum of the external diameter of the largest external diameter
37 endotracheal tube in an operating range of endotracheal tube sizes plus the mean thickness

of the inferior tube guiding member plus the mean thickness of the first superior tube guiding member, the insertion section is narrower at the first region in use than would be the case if tube guiding members of the same thickness as the inferior and first superior tube guiding members were provided in the first region and spaced apart sufficiently to receive an endotracheal tube having the largest external diameter in an operating range of endotracheal tubes.

By the external diameter of the largest external diameter endotracheal tube in an operating range of endotracheal tube sizes, we refer to the external diameter of the largest external diameter endotracheal tubes with which the insertion section can be reliably used. This will depend on the scale of the insertion section which will itself depend on the application of the insertion section. An insertion section for use with adult humans may, for example, be adapted to be usable reliably with endotracheal tubes with an external diameter of up to 12.3mm. Tubes of this external diameter are referred to as Size 9.0 in the field. The minimum external diameter may be around 5.5mm. Where the insertion section is made from a plastics material, the mean thickness of the inferior and first superior tube guiding members typically requires to be at least 0.75mm (preferably around 1.5mm) to provide suitable mechanical strength for internal use. Accordingly, the thickness of the first region is preferably less than 15.3mm, more preferably less than 14.6mm, 13.8mm or more preferably less than 13.1mm, in the case of an insertion section for inserting endotracheal tubes into adult humans.

The dimensions of an insertion section for use with infant humans, including new born infants, are typically scaled proportionately from the dimensions of an insertion section for use with human adults. Nevertheless, the proportions of some features, such as the thickness of the tube guiding members, may not scale proportionately. In the case of an insertion section for inserting endotracheal tubes into infant humans, including new born infants, the operating range of external tube diameters may be 1.0 to 5.0mm, and the thickness of the first region is preferably less than 8.0mm, preferably less than 7.0mm, or more preferably less than 6.0mm.

The thickness of the insertion section at the first region may be less than the external diameter of the largest diameter endotracheal tube in the operating range of endotracheal tube sizes.

The first region may extend from the proximal end of the insertion section to the proximal end of the tube guiding surface of the first superior tube contacting member. The first region may

1 extend from the proximal end of the insertion section to the proximal end of the first superior
2 tube contacting member. The first region may include part of the proximal half of the
3 insertion section but not extend to the proximal end of the insertion section. The first region
4 preferably comprises a region of the insertion section which is close to a patient's teeth when
5 the insertion section is fully inserted into a patient, as this can reduce the risk of damage to a
6 patient's teeth.

7
8 The insertion section is typically curved such that at least a portion of the superior surface is
9 excurve and at least a portion of the inferior surface is incurvate. The first superior tube
10 guiding member is typically provided towards the distal end of the insertion section.
11 Preferably, the first superior tube guiding member is provided close to, but not at, the distal
12 end of the insertion section. Typically, the first superior tube guiding member guides a
13 retained endotracheal tube towards a patient's larynx. Typically, the tube guiding surface of
14 the first superior tube guiding member and the tube guiding surface of the inferior tube
15 guiding member together guide a retained endotracheal tube towards a patient's trachea in
16 use.

17
18 Typically, the tube guiding surface of the first superior tube guiding member is the most distal
19 location where the insertion section contacts the superior surface of a retained endotracheal
20 tube. Typically, the tube guiding surface of the inferior tube guiding member is the most
21 distal location where the insertion section contacts the inferior surface of a retained
22 endotracheal tube for endotracheal tubes of a range of external diameters (typically at the
23 upper end of the operating range of endotracheal tube sizes). The insertion section may be
24 configured such that endotracheal tubes at the lower end of the operating range of
25 endotracheal tube sizes do not contact the inferior tube guiding member opposite the first
26 superior tube guiding member but endotracheal tubes at the upper end of the operating range
27 of endotracheal tube sizes do contact the inferior tube guiding member opposite the first
28 superior tube guiding member.

29
30 Preferably, the tube guide is arranged to guide a retained endotracheal tube such that the
31 inferior surface of a retained endotracheal tube is inferior of the superior surface of the
32 insertion section and the superior surface of a retained endotracheal tube is superior of the
33 inferior surface of a retained endotracheal tube at least in the first region and typically from
34 where the insertion section extends between a patient's teeth in use and the first superior
35 tube guiding member. This arrangement fits better with the general shape of the oral cavity
36 than devices where the endotracheal tube is retained entirely inferiorly or entirely superiorly
37 of the insertion section at a corresponding region.

1
2 The insertion section typically comprises a curved portion (for example, the insertion section
3 may be entirely curved) such that the inferior surface of the insertion section is incurvate and
4 the superior surface of the insertion section is excurved. The first superior tube guiding
5 member is located sufficient distally of the first region to guide a retained tube at an angle of
6 at least 20°, and preferably at least 30° to the angle at which a retained tube is guided in the
7 first region. The first superior tube guiding member is preferably arranged to guide an
8 endotracheal tube towards a patient's larynx when the insertion section is fully inserted in
9 use.

10
11 The first region of the insertion section which has a thickness which is less than the sum of
12 the external diameter of the largest external diameter endotracheal tube in an operating
13 range of endotracheal tube sizes plus the mean thickness of the inferior tube guiding member
14 plus the mean thickness of the first superior tube guiding member preferably extends along at
15 least 1cm of the length of the insertion section. More preferably, the first region extends
16 along at least 1.5cm, and more preferably at least 2.5cm, of the length of the insertion section
17 which is close to a patient's teeth in use, to provide a user with an insertion section which is
18 relatively thin along a significant length of the insertion section to increase manoeuvrability
19 and reduce the risk of damage to a patient's teeth.

20
21 The plurality of tube guiding members may further comprise a second superior tube guiding
22 member having a tube guiding surface on an inferior side thereof for contacting and thereby
23 guiding the superior surface of a retained endotracheal tube, wherein the second superior
24 tube guiding member is proximal of the first superior tube guiding member and the tube
25 guiding surfaces of the first and second superior tube guiding members are spaced apart.
26 Thus, the superior surface of a retained endotracheal tube will typically be exposed between
27 the first and second superior tube guiding members.

28
29 In an insertion section for the intubation of human adults, the tube guiding surfaces of the first
30 and second superior tube guiding members are typically spaced apart by at least 2cm, more
31 preferably at least 4cm and most preferably at least 6cm. When the insertion section is
32 curved, the direction of the insertion section at the first superior tube guiding member
33 typically differs by at least 20° and preferably at least 30° from the direction of the insertion
34 section at the second superior tube guiding member.

35
36 Preferably, the first superior tube guiding member is located towards, but not at, the distal
37 end of the insertion section.

1
2 The second superior tube guiding member may be arranged to be located close to the teeth
3 of a patient of typical dimensions when the insertion section is fully inserted into a patient.
4 The first region may comprise some or all of the second superior tube guiding member. The
5 second superior tube guiding member may be located proximal of the teeth of a patient of
6 typical dimensions when the insertion section is fully inserted into a patient such that it would
7 not pass into the oral cavity of a patient of typical dimensions in use.

8
9 Preferably, the insertion section is arranged to leave the inferior surface of a retained
10 endotracheal tube exposed opposite the second superior tube guiding member. Typically, no
11 inferior tube guiding member is provided opposite the second superior tube guiding member.

12
13 Preferably, the insertion section is arranged to leave the superior surface of a retained
14 endotracheal tube exposed opposite at least the proximal end of and optionally all of the
15 inferior tube guiding member. It may be that no superior tube guiding member is provided
16 opposite at least the proximal end of and optionally all of the inferior tube guiding member.

17
18 Thus, at least a region of the insertion section close to a patient's teeth in use is narrower
19 than would be the case if an inferior tube guiding member was provided opposite the second
20 superior tube guiding member and spaced apart from the second tube guiding member so as
21 to leave a gap therebetween with a thickness at least equal to the external diameter of the
22 largest endotracheal tube in an operating range of endotracheal tubes.

23
24 Preferably, the distal end of the tube guiding surface of the second superior tube guiding
25 member and the proximal end of the tube guiding surface of the inferior tube guiding member
26 are spaced apart along the length of the insertion section, preferably by at least 0.5cm, more
27 preferably by at least 1cm and most preferably by at least 2cm. Preferably also, the distal
28 end of the second tube guiding member and the proximal end of the inferior tube guiding
29 member are spaced apart along the length of the insertion section, preferably by at least
30 0.5cm, preferably by at least 1cm and most preferably by at least 2cm.

31
32 Preferably, the component which is parallel to a superior-inferior axis of the displacement
33 between the distal end of the tube guiding surface of the second superior tube guiding
34 member and the proximal end of the tube guiding surface of the inferior tube guiding member
35 is less than the external diameter of the largest external diameter endotracheal tube in an
36 operating range of endotracheal tube sizes. Preferably also, the distance between the distal
37 end of the second tube guiding member and the inferior tube guiding member, parallel to a

superior-inferior axis, is less than the external diameter of the largest external diameter endotracheal tube in an operating range of endotracheal tube sizes.

Thus, the tube guide may be arranged to receive an endotracheal tube other than parallel to the length of the insertion section, for example, the tube guide may be arranged to receive an endotracheal tube such that it extends distally and superiorly between the proximal end of the tube guiding surface of the inferior tube guiding member and the distal end of the tube guiding surface of the second superior tube guiding member.

Preferably, the thickness of the insertion section between the second superior tube guiding member and the first tube guiding member is less than the thickness of the insertion section at one and preferably both of the first and second superior tube guiding members.

Preferably, the tube guide is arranged such that, for endotracheal tubes of a range of external diameters (typically including endotracheal tubes having the largest external diameter in an operating range of endotracheal tube sizes) a retained endotracheal tube will not be retained parallel to the length of the insertion section but have a different radius of curvature to the insertion section along at least a portion of the insertion section (typically from the most proximal location where the insertion section contacts the superior surface of a retained endotracheal tube to the most distal location where the insertion section contacts the superior surface of a retained endotracheal tube). The tube guide may be arranged such that endotracheal tubes having an external diameter at the top end of the operating range of endotracheal tube sizes are retained with a smaller radius of curvature than the insertion section along at least a portion of the insertion section (typically from the most proximal location where the insertion section contacts the superior surface of a retained endotracheal tube to the most distal location where the insertion section contacts the superior surface of a retained endotracheal tube). The tube guide may be arranged such that endotracheal tubes having an external diameter at the bottom end of the operating range of endotracheal tube sizes are retained with a higher radius of curvature than the insertion section along at least a portion of the insertion section (typically from the most proximal location where the insertion section contacts the superior surface of a retained endotracheal tube to the most distal location where the insertion section contacts the superior surface of a retained endotracheal tube).

In particular, the plurality of tube guiding members may comprise a second superior tube guiding member having a tube guiding surface which is spaced apart from the tube guiding surface of the first superior tube guiding member and arranged such that, for endotracheal

1 tubes of a range of external diameters (typically including endotracheal tubes having the
2 largest external diameter in an operating range of endotracheal tube sizes), a retained
3 endotracheal tube will not be retained parallel to the length of the insertion section between
4 the first and second superior tube guiding members.

5
6 The tube guide may be arranged such that, for at least some endotracheal tubes with an
7 external diameter within an operating range of external diameters, the superior surface of a
8 said retained endotracheal tube extends superiorly of the superior surface of the insertion
9 section (typically the superior surface of the elongate member, where provided), along at
10 least a portion of the length of the insertion section, towards the middle of the insertion
11 section. Typically, the tube guide is arranged such that, for at least some endotracheal tubes
12 with an external diameter within an operating range of external diameters, the superior
13 surface of retained said endotracheal tube extends superiorly of the superior surface of the
14 insertion section at at least one location between the first and second superior tube guiding
15 members, where provided.

16
17 Preferably, the tube guiding members are arranged such that, for endotracheal tubes having
18 a range of external diameters within the operating range of endotracheal tube external
19 diameters (typically at the upper end of the operating range of endotracheal tube external
20 diameters) a retained endotracheal tube will typically contact the tube guiding surface of
21 either one of or preferably both the proximal and distal superior tube guiding members only at
22 the distal ends of the respective tube guiding member, when a retained endotracheal tube is
23 at rest, retained within the tube guide. Endotracheal tubes having a range of external
24 diameters within the operating range of endotracheal tube external diameters (typically at the
25 upper end of the operating range of endotracheal tube external diameters) may only contact
26 the tube guiding surface of the inferior tube guiding member at the proximal end of the tube
27 guiding surface, when a retained endotracheal tube is at rest, retained within the tube guide.
28 This arrangement reduces friction when the endotracheal tube is subsequently advanced
29 towards a patient's larynx.

30
31 Preferably, the tube guide is arranged to retain an endotracheal tube under flexural tension
32 from the most proximal location where the tube guide contacts the superior surface of a
33 retained endotracheal tube to the most distal location where the tube guide contacts the
34 superior surface of a retained endotracheal tube. This facilitates retention of the
35 endotracheal tube within the tube guide. Preferably, the tube guide also contacts the inferior
36 surface of a retained endotracheal tube intermediate the most proximal and most distal
37 locations where the tube guide contacts the superior surface of a retained endotracheal tube,

1 such that a retained endotracheal tube exerts a superior force on the tube guide at the most
2 proximal and most distal locations where the tube guide contacts the superior surface of a
3 retained endotracheal tube and an inferior force at the said location where the tube guide
4 contacts the inferior surface of a retained endotracheal tube. The use of at least three points
5 of contact facilitates grip. The retention of an endotracheal tube under flexural tension is of
6 particular benefit where the tube guide opens laterally as the flexural tension increases the
7 friction which opposes lateral movement of the retained endotracheal tube. Nevertheless,
8 the use of only three points of contact reduces friction when the endotracheal tube is advance
9 longitudinally compared to an arrangement in which a retained endotracheal tube is in
10 contact with a guide wall along a substantial portion of the tube guide.

11
12 The tube guiding surface of the first superior tube guiding member may extend distally and
13 inferiorly (i.e. such that it extends inferiorly towards the distal end) at an angle to the insertion
14 section. Similarly, the second superior tube guiding member, where present, may extend
15 distally and superiorly (i.e. such that it extends superiorly towards the distal end). This
16 facilitates the retention of an endotracheal tube in a curved configuration, under flexural
17 tension.

18
19 The tube guide may be arranged such that, for endotracheal tubes of a range of external
20 diameters (typically including endotracheal tubes having the largest external diameter in an
21 operating range of endotracheal tube sizes), a retained endotracheal tube is continuously
22 curved from where it extends into a patient's mouth when it is fully inserted in use to the first
23 superior tube guiding member. Where a second superior tube guiding member is provided,
24 the tube guide may be arranged such that, for endotracheal tubes of a range of external
25 diameters (typically including endotracheal tubes having the largest external diameter in an
26 operating range of endotracheal tube sizes), a retained endotracheal tube is continuously
27 curved from the second superior tube guiding member to the first superior tube guiding
28 member.

29
30 The curvature may or may not be constant.

31
32 Where the tube guiding surfaces of the first and second superior tube guiding members are
33 spaced apart such that the superior surface of a retained endotracheal tube is exposed
34 between the first and second superior tube guiding members, and the tube guide is arranged
35 so that for endotracheal tubes of a range of external diameters (typically including
36 endotracheal tubes having the largest external diameter in an operating range of
37 endotracheal tube sizes), said retained endotracheal tubes are continuously curved from

1 where they extend into a patient's mouth when the insertion section is fully inserted in use to
2 the first superior tube guiding member, this enables the insertion section and tube guide to be
3 used with endotracheal tubes of a wider range of diameters than would be the case for a tube
4 guide defined by continuous inferior and superior tube guiding surfaces.

5
6 Preferably, the insertion section only includes one or more tube guiding surfaces which
7 extend to contact and thereby guide the inferior surface of a retained endotracheal tube
8 distally of a patient's teeth when the insertion section is fully inserted into a patient.
9 Accordingly, the tube guide preferably only covers the inferior surface of a retained
10 endotracheal tube distally of a patient's teeth when the insertion section is fully inserted into a
11 patient.

12
13 The tube guiding surface of the inferior tube guiding member preferably extends proximally of
14 the tube guiding surface of the first superior tube guiding member. Thus, the inferior surface
15 of a retained endotracheal tube may be guided proximally of the first superior tube guiding
16 member without the superior surface of a retained endotracheal tube being guided along the
17 entire length of the tube guiding surface of the inferior tube guiding member. This reduces
18 the overall bulk of the insertion section as a retained tube can be guided adequately using a
19 first superior tube guiding member with only a relatively short tube guiding surface and an
20 inferior tube guiding member with a tube guiding surface which extends distally of the tube
21 guiding surface of the first superior tube guiding member. Preferably, the tube guiding
22 surface of the inferior tube guiding member extends at least 1cm, preferably at least 2cm and
23 most preferably 4 to 5cm proximally of the tube guiding surface of the first superior tube
24 guiding member. The tube guiding surface of the inferior tube guiding member may be
25 entirely proximal of the tube guiding surface of the first superior tube guiding member, further
26 reducing bulk.

27
28 Preferably, the tube guide is arranged such that a retained endotracheal tube can be
29 removed laterally from the tube guide. This facilitates removal of the endotracheal tube in
30 situ within a patient. Preferably, the insertion section is arranged such that a retained
31 endotracheal tube remains exposed along an entire lateral side (e.g. along the entirety of the
32 most lateral point on the tube, along the length of the tube). By avoiding covering the lateral
33 side of a retained endotracheal tube, the overall bulk of the insertion section is reduced.

34
35 Preferably, the insertion section comprises an elongate member which extends along the
36 majority of the length of the insertion section, with the tube guide arranged to retain an
37 endotracheal tube laterally of the elongate member. The tube guiding members preferably

1 extend laterally of, and typically from, the elongate member. The elongate member may
2 comprise imaging apparatus, such as an imaging device (e.g. a camera) or image conduction
3 apparatus (such as one or more fibre optic cables or one or more reflective surfaces) for
4 imaging a patient's laryngeal area in use. The elongate member may comprise illumination
5 apparatus, such as a light source, including a bulb or one or more fibre optical cables through
6 which light may be conducted, for illuminating a patient's laryngopharynx in use. The
7 elongate member may conduct one or more cable therein, such as electrical wires which
8 relay signals from an imaging device and/or provide power to an imaging device and/or light
9 source, where present.

10
11 The elongate member may define a bore therein, which typically extends from the proximal
12 end of the elongate member, which may be a through-bore which is open at both ends or
13 which may be enclosed at a distal end of the bore. The bore may be configured to receive
14 imaging apparatus and/or illumination apparatus. The bore may be configured to receive an
15 elongate insertion section supporting member which resists flexing of the insertion section.
16 The bore may be configured to receive an elongate insertion section supporting member
17 which comprises imaging apparatus and/or illumination apparatus. Where the bore is
18 enclosed at a distal end, the elongate member is preferably liquid tight to prevent
19 contamination of imaging apparatus and/or illumination apparatus enclosed therein.

20
21 Preferably, at at least one location where the insertion section comprises a said elongate
22 member with an adjacent tube guide, the elongate member and tube guide are configured
23 such that the thickness of the elongate member is less than the thickness of the adjacent
24 tube guide plus the external diameter of a retained endotracheal tube having the largest
25 external diameter in the operating range of endotracheal tube sizes. The said location may
26 be adjacent to the first superior tube guiding member. The said location may be adjacent to
27 the inferior tube guiding member. The said location may be adjacent to the second superior
28 tube guiding member, where provided.

29
30 Accordingly, by providing an elongate member which is narrower than the adjacent tube
31 guide, we provide an insertion section which is less bulky than would be the case if the
32 elongate member was the same thickness as the tube guide.

33
34 Preferably, at at least one location where the tube guide comprises a superior tube guiding
35 member, such as the first superior tube guiding member, or a further tube guiding member
36 which is proximal of the first superior tube guiding member, where provided, the superior tube

1 guiding member extends further in a superior direction than the elongate member, adjacent
2 to the superior tube guiding member.

3
4 Preferably, at at least one location where the tube guide comprises an inferior tube guiding
5 member, the inferior tube guiding member extends further in an inferior direction than the
6 elongate member, adjacent to the inferior tube guiding member.

7
8 Accordingly, by providing a superior tube guiding member which extends further in a superior
9 direction than the adjacent elongate member and/or an inferior tube guiding member which
10 extends further in a superior direction than the adjacent elongate member, a less bulky
11 insertion section with a lateral tube guide is provided than would be the case if the superior
12 tube guiding member did not extend further in a superior direction than the adjacent elongate
13 member and/or the inferior tube guiding member did not extend further in an inferior direction
14 than the adjacent elongate member.

15
16 Preferably, where the insertion section comprises an elongate member with an adjacent tube
17 guide arranged to retain an endotracheal tube laterally of the elongate member, there is at
18 least one location, proximal of the first superior tube guiding member, where an endotracheal
19 tube is retained in use laterally of the elongate member with the inferior and superior sides of
20 the endotracheal tube being left exposed. Preferably, no tube guiding member is provided at
21 the location. Where first and second superior tube guiding members are provided, the said
22 location is typically intermediate the first and second superior tube guiding members.

23
24 In the first region, or a portion of the first region, a retained endotracheal tube at the upper
25 end of the operating range of endotracheal tube sizes may have both its inferior and superior
26 surfaces left exposed in use and extend inferiorly and superiorly of an adjacent section of
27 elongate member. Thus, in the first region, or a portion of the first region, the thickness of the
28 insertion section may be less than three-quarters, or preferably less than half of the external
29 diameter of the largest external diameter endotracheal tube in an operating range of
30 endotracheal tube sizes.

31
32 Preferably, the first superior tube guiding member extends laterally and superiorly from the
33 elongate member, from the superior surface of the elongate member or from the lateral edge
34 of the elongate member intermediate the inferior and superior surfaces of the elongate
35 member. Where a second superior tube guiding member is provided, the second superior
36 tube guiding member preferably extends laterally and superiorly from the elongate member,

1 from the superior surface of the elongate member or from the lateral edge of the elongate
2 member intermediate the inferior and superior surfaces of the elongate member

3
4 The first superior tube guiding member and/or second superior tube guiding member, where
5 present, typically comprises a lateral portion which is arranged to extend distally and inferiorly
6 beyond the midline of a retained endotracheal tube. Thus, the tube guiding surface of the
7 first superior tube guiding member (and second superior tube guiding member when present)
8 is typically incurvate.

9
10 Preferably, the inferior tube guiding member extends laterally and inferiorly from the elongate
11 member. The inferior tube guiding member typically comprises a lateral portion which is
12 arranged to extend distally and superiorly beyond the midline of a retained endotracheal
13 tube. This, the tube guiding surface of the inferior tube guiding member is typically incurvate.

14
15 Preferably, the lateral extent of the tube guiding members from the elongate member
16 exceeds at least 50%, more preferably at least 60%, or more preferably at least 70% of the
17 diameter of the largest endotracheal tubes in an operating range of endotracheal tube sizes
18 in order to extend past the midline of and thereby guide endotracheal tubes. For example,
19 where the operating range of endotracheal tube sizes extends up to 12.3mm, the tube
20 guiding members preferably extend at least 6.1mm (more preferably at least 7.3mm and most
21 preferably at least 8.5mm) laterally from the elongate member. Where the operating range of
22 endotracheal tube sizes extends up to 5.0mm, the tube guiding members preferably extend
23 at least 2.5mm laterally from the elongate member.

24
25 The inferior tube guiding member is preferably continuous but may alternatively be
26 discontinuous. Where an elongate member is present, the inferior tube guiding member
27 typically extends from, or from near, the inferior side of the elongate member. The inferior
28 surface of the tube guiding member may be level with the inferior side of the tube guide. The
29 inferior tube guiding member may extend to the distal end of the insertion section.

30
31 The first superior tube guiding member may comprise two or more separate portions or be
32 continuous. Where present, the second superior tube guiding member may comprise two or
33 more separate portions or be continuous.

34
35 Preferably, the insertion section is arranged so that an intubater can contact an endotracheal
36 tube retained by the tube guide within a patient's mouth, in use. This increases the amount
37 of control which is available to the intubater and may be preferred by intubaters who have

1 been trained to carry out intubation using traditional laryngoscopes, who are used to being
2 able to manipulate the endotracheal tube within the patient's mouth. Where the insertion
3 section comprises a second superior tube guiding member having a tube guiding surface
4 which is spaced apart from the tube guiding surface of the first superior tube guiding member,
5 the insertion section may be arranged so that an intubater can contact an endotracheal tube
6 distally of the tube guiding surface of the section superior tube guiding member. The
7 insertion section may be arranged to that an intubater can contact one or more of the inferior
8 or superior surfaces of an endotracheal tube retained within the tube guide within a patient's
9 mouth, in use (e.g. distally of the distally of the tube guiding surface of the second superior
10 tube guiding member, where present). The insertion section may be arranged to that an
11 intubater can contact a lateral surface of an endotracheal tube retained within the tube guide
12 within a patient's mouth, in use (e.g. distally of the distally of the tube guiding surface of the
13 second superior tube guiding member, where present). The insertion section may be
14 arranged so that an intubater can contact opposite inferior and superior surfaces of the
15 endotracheal tube within a patient's mouth, in use, (e.g. distally of the distally of the tube
16 guiding surface of the second superior tube guiding member, where present), to facilitate grip
17 and enable them to gently pinch the tube.

18
19 Preferably, the insertion section is rigid. Preferably, at least part of the insertion section is
20 transparent. The insertion section may be made from a plastics material. The insertion
21 section may be moulded from a plastics material. The insertion section may be monolithic.
22 Where the insertion section comprises an elongate member having a bore, the insertion
23 section may function to protect optical apparatus within the bore in use. Accordingly, the
24 insertion section may be disposable.

25
26 The insertion section may be an integral part of a laryngoscope, which may comprise a
27 handle. The insertion section may be removably attachable to a laryngoscope body, which
28 may comprise a handle. The insertion section may function as a laryngoscope.

29
30 Preferably, the insertion section is of suitable size for use in the intubation of adults.
31 Preferably, the operating range of endotracheal tube sizes includes endotracheal tubes
32 having an external diameter of 12.3mm. The relevance of this size is that this is the external
33 diameter of what is generally referred to in the industry as Size 9.0 endotracheal tubes, being
34 one of the largest sizes in common use. However, tubes of this size are sufficiently broad to
35 present an engineering challenge if an insertion section is to be provided with an integral tube
36 guide which capable of operating reliably with tubes of these size but does not present an
37 obstruction.

1
2 According to a second aspect of the present invention there is provided an elongate
3 laryngoscope insertion section having a proximal end and a distal end for insertion into a
4 patient's oral cavity in use, the insertion section comprising a tube guide for removably
5 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
6 larynx, the tube guide comprising a plurality of tube guiding members having tube guiding
7 surfaces which are arranged to contact and thereby guide the inferior or superior surface of a
8 retained endotracheal tube, the plurality of tube guiding members comprising at least an
9 inferior tube guiding member having a tube guiding surface on a superior side thereof for
10 contacting and thereby guiding the inferior surface of a retained endotracheal tube, and first
11 and second superior tube guiding members each of which has a tube guiding surface on an
12 inferior side thereof for contacting and thereby guiding the superior surface of a retained
13 endotracheal tube, wherein the second superior tube guiding member is proximal of the first
14 superior tube guiding member and the tube guiding surfaces of the first and second superior
15 tube guiding members are spaced apart, wherein the tube guide is arranged to leave
16 exposed the inferior surface of a retained endotracheal tube opposite the tube guiding
17 surface of the second superior tube guiding member.

18
19 According to a third aspect of the present invention there is provided an elongate
20 laryngoscope insertion section having a proximal end and a distal end for insertion into a
21 patient's oral cavity in use, the insertion section comprising a tube guide for removably
22 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
23 larynx, the tube guide comprising a plurality of tube guiding members having tube guiding
24 surfaces which are arranged to contact and thereby guide the inferior or superior surface of a
25 retained endotracheal tube, the plurality of tube guiding members comprising at least an
26 inferior tube guiding member having a tube guiding surface on a superior side thereof for
27 contacting and thereby guiding the inferior surface of a retained endotracheal tube, and a first
28 superior tube guiding member having a tube guiding surface on an inferior side thereof for
29 contacting and thereby guiding the superior surface of a retained endotracheal tube, wherein
30 the tube guiding surface of the inferior tube guiding member extends proximally of the tube
31 guiding surface of the first tube guiding member.

32
33 The tube guide may further comprise a second superior tube guiding member which has a
34 tube guiding surface on an inferior side thereof for contacting and thereby guiding the
35 superior surface of a retained endotracheal tube, wherein the second superior tube guiding
36 member is proximal of the first superior tube guiding member and the tube guiding surfaces
37 of the first and second superior tube guiding members are spaced apart, wherein the tube

1 guiding surface of the second superior tube guiding member is spaced apart from and
2 proximal of the proximal end of the tube guiding surface of the inferior tube guiding member,
3 such that an endotracheal tube can be introduced into the tube guide between the proximal
4 end of the tube guiding surface of the inferior tube guiding member and the distal end of the
5 tube guiding surface of the superior tube contacting member at an angle to the length of the
6 insertion section at the proximal end of the tube guiding surface of the inferior tube guiding
7 member.

8
9 According to a fourth aspect of the present invention there is provided an elongate
10 laryngoscope insertion section having a proximal end and a distal end for insertion into a
11 patient's oral cavity in use, the insertion section comprising a tube guide for removably
12 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
13 larynx, the tube guide comprising a plurality of tube guiding members having tube guiding
14 surfaces which are arranged to contact and thereby guide the inferior or superior surface of a
15 retained endotracheal tube, the plurality of tube guiding members comprising at least an
16 inferior tube guiding member having a tube guiding surface on a superior side thereof for
17 contacting and thereby guiding the inferior surface of a retained endotracheal tube, and a first
18 superior tube guiding member at the distal end of the tube guide having a tube guiding
19 surface on an inferior side thereof for contacting and thereby guiding the superior surface of a
20 retained endotracheal tube, wherein the tube guide is arranged so that, for endotracheal
21 tubes of a range of external diameters, a retained endotracheal tube will be continuously
22 curved at least from where a retained endotracheal tube extends through a patient's teeth
23 when the insertion section is inserted fully into a patient to the first superior tube guiding
24 member.

25
26 As the tube guide is arranged to retain an endotracheal tube such that it is curved at least
27 from where a retained endotracheal tube extends through a patient's teeth when the insertion
28 section is inserted fully into a patient to the first superior tube guiding member, the tube will
29 be easier to insert than would be the case if the endotracheal tube was retained in a
30 generally J-shaped formation and the insertion section will be easier to insert than if the
31 insertion section was arranged in a generally J-shaped formation.

32
33 The tube guide may be arranged to retain the endotracheal tube with a constant radius of
34 curvature.

35
36 The tube guide may be arranged such that a retained endotracheal tube has a greater
37 curvature between where it extends through a patient's teeth when the insertion section is

1 inserted fully into a patient and the first superior tube guiding member than the curvature of
2 the insertion section between where it extends through a patient's teeth when the insertion
3 section is inserted fully into a patient and the first superior tube guiding member.

4
5 According to a fifth aspect of the present invention there is provided an elongate
6 laryngoscope insertion section having a proximal end and a distal end for insertion into a
7 patient's oral cavity in use, the insertion section comprising a tube guide for removably
8 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
9 larynx and an elongate member, wherein the tube guide comprises a plurality of tube guiding
10 members which extend laterally of the elongate member having tube guiding surfaces which
11 are arranged to contact and thereby guide the inferior or superior surface of a retained
12 endotracheal tube, the plurality of tube guiding members comprising at least an inferior tube
13 guiding member having a tube guiding surface on a superior side thereof for contacting and
14 thereby guiding the inferior surface of a retained endotracheal tube, and a first superior tube
15 guiding member having a tube guiding surface on an inferior side thereof for contacting and
16 thereby guiding the superior surface of a retained endotracheal tube, wherein, at at least one
17 location along the length of the insertion section, the thickness of the elongate member is
18 less than the thickness of the adjacent tube guide.

19
20 According to a sixth aspect of the present invention there is provided an elongate
21 laryngoscope insertion section having a proximal end and a distal end for insertion into a
22 patient's oral cavity in use, the insertion section comprising a tube guide for removably
23 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
24 larynx and an elongate member, wherein the tube guide comprises a plurality of tube guiding
25 members which extend laterally of the elongate member and have tube guiding surfaces
26 which are arranged to contact and thereby guide the inferior or superior surface of a retained
27 endotracheal tube, the plurality of tube guiding members comprising at least an inferior tube
28 guiding member having a tube guiding surface on a superior side thereof for contacting and
29 thereby guiding the inferior surface of a retained endotracheal tube, and a first superior tube
30 guiding member having a tube guiding surface on an inferior side thereof for contacting and
31 thereby guiding the superior surface of a retained endotracheal tube, wherein either or both
32 (i) the inferior tube guiding member extends further in an inferior direction than the elongate
33 member adjacent to the inferior tube guiding member or (ii) the superior tube guiding member
34 extends further in a superior direction than the elongate member adjacent to the superior
35 tube guiding member.

1 According to a seventh aspect of the present invention there is provided an elongate
2 laryngoscope insertion section having a proximal end and a distal end for insertion into a
3 patient's oral cavity in use, the insertion section comprising a tube guide for removably
4 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
5 larynx, wherein the tube guide is adapted to retain endotracheal tubes with a range of
6 external diameters within an operating range of endotracheal tube external diameters, under
7 flexural tension.

8
9 Preferably, the tube guide comprises a plurality of tube guiding members having tube guiding
10 surfaces which are arranged to contact and thereby guide the inferior or superior surface of a
11 retained endotracheal tube, the plurality of tube guiding members comprising at least an
12 inferior tube guiding member having a tube guiding surface on a superior side thereof for
13 contacting and thereby guiding the inferior surface of a retained endotracheal tube, a first
14 superior tube guiding member having a tube guiding surface on an inferior side thereof for
15 contacting and thereby guiding the superior surface of a retained endotracheal tube, and a
16 second superior tube guiding member located proximally of the first superior tube guiding
17 member and having a tube guiding surface on an inferior side thereof for contacting and
18 thereby guiding the superior surface of a retained endotracheal tube, wherein the tube
19 guiding surfaces of the first and second superior tube guiding members are spaced apart,
20 with at least a portion of the tube guiding surface of the inferior tube guiding member being
21 proximal of the proximal end of the tube guiding surface of the first superior tube guiding
22 member and distal of the distal end of the tube guiding surface of the second superior tube
23 guiding member, wherein the tube guiding members are arranged to retain endotracheal
24 tubes with a range of external diameters within an operating range of endotracheal tube
25 external diameters under flexural tension such that a retained endotracheal tube exerts a
26 force in a superior direction on the first and second superior tube guiding members applying
27 a force in an inferior direction and a force in an inferior direction on the inferior tube guiding
28 member.

29
30 Preferably, the tube guide is arranged to that a retained endotracheal tube can be removed
31 laterally from the tube guide. More preferably, the insertion section comprises an elongate
32 member and the tube guiding members extend laterally from the elongate member.

33
34 According to an eighth aspect of the present invention there is provided an elongate
35 laryngoscope insertion section having a proximal end and a distal end for insertion into a
36 patient's oral cavity in use, the insertion section comprising a tube guide for removably
37 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's

1 larynx and an elongate member, wherein the tube guide comprises a plurality of tube guiding
2 members which extend laterally of the elongate member and have tube guiding surfaces
3 which are arranged to contact and thereby guide the inferior or superior surface of a retained
4 endotracheal tube, the plurality of tube guiding members comprising at least an inferior tube
5 guiding member having a tube guiding surface on a superior side thereof for contacting and
6 thereby guiding the inferior surface of a retained endotracheal tube, and a first superior tube
7 guiding member having a tube guiding surface on an inferior side thereof for contacting and
8 thereby guiding the superior surface of a retained endotracheal tube, wherein there is at least
9 one location, proximal of the first superior tube guiding member, where an endotracheal tube
10 is retained in use laterally of the elongate member with the inferior and superior sides of the
11 endotracheal tube being left exposed.

12
13 According to a ninth aspect of the present invention there is provided an elongate
14 laryngoscope insertion section having a proximal end and a distal end for insertion into a
15 patient's oral cavity in use, the insertion section comprising a tube guide for removably
16 retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's
17 larynx, wherein the insertion section and tube guide are arranged to leave the inferior or
18 superior surface of a retained endotracheal tube exposed along at least 25% and preferably
19 50% or more preferably 75% of the length of the insertion section between the most proximal
20 location where the insertion section contacts a retained endotracheal tube and the most distal
21 location where the insertion section contacts a retained endotracheal tube.

22
23 Preferably, the inferior surface of a retained endotracheal tube is left exposed along at least
24 25% and preferably 50% or more preferably 75% of the length of the insertion section
25 between the most proximal location where the insertion section contacts a retained
26 endotracheal tube and the most distal location where the insertion section contacts a retained
27 endotracheal tube.

28
29 Preferably, the superior surface of a retained endotracheal tube is left exposed along at least
30 25% and preferably 50% or more preferably 75% of the length of the insertion section
31 between the most proximal location where the insertion section contacts a retained
32 endotracheal tube and the most distal location where the insertion section contacts a retained
33 endotracheal tube.

34
35 Preferably, both the inferior and superior surface of a retained endotracheal tube are left
36 exposed along a continuous region of at least 5% or preferably at least 10% of the length of
37 the insertion section between the most proximal location where the insertion section contacts

1 a retained endotracheal tube and the most distal location where the insertion section contacts
2 a retained endotracheal tube. Preferably, the continuous region is located close to the teeth
3 of a patient of typical dimensions when the insertion section is inserted fully into a patient in
4 use.

5
6 Preferably, the tube guide is arranged to enable a retained endotracheal tube to be removed
7 laterally from the tube guide and a retained endotracheal tube is retained with its lateral side
8 at least partially exposed along the entire length of the insertion section.

9
10 Preferably, the insertion section comprises an elongate member, wherein the tube guide
11 comprises a plurality of tube guiding members which extend laterally of the elongate member
12 and have tube guiding surfaces which are arranged to contact and thereby guide the inferior
13 or superior surface of a retained endotracheal tube, the plurality of tube guiding members
14 comprising at least a first superior tube guiding member having a tube guiding surface on an
15 inferior side thereof for contacting and thereby guiding the superior surface of a retained
16 endotracheal tube and a second superior tube guiding member having a tube guiding surface
17 on an inferior side thereof for contacting and thereby guiding the superior surface of a
18 retained endotracheal tube, wherein the second superior tube guiding member is located
19 proximally of the first superior tube guiding member and the tube guiding surfaces of the first
20 and second superior tube guiding members are spaced apart, wherein the tube guiding
21 surface of the second superior tube guiding member is the most proximal location where the
22 insertion section contacts a retained endotracheal tube. The tube guiding surface of the first
23 superior tube guiding member is preferably the most distal location where the insertion
24 section contacts the superior side of a retained endotracheal tube and the tube guiding
25 surface of the first superior tube guiding member may be the most distal location where the
26 insertion section contacts a retained endotracheal tube.

27
28 Optional features discussed in relation to any of the first through ninth aspects of the
29 invention are optional features of any of the first through ninth aspects of the invention.

30
31 The invention also extends, in a tenth aspect, to a laryngoscope comprising a handle and an
32 elongate insertion section according to any one of the first nine aspects of the invention.

33
34 The insertion section may be fixedly attached to the handle. Alternatively, the laryngoscope
35 may comprise a body which comprises the handle and the elongate insertion section may be
36 detachably retainable on the body. The insertion section may comprise an elongate member
37 having a bore therein and the body may comprise an insertion section supporting member

1 which extends into and support the insertion section. Further optional and preferred features
2 of the insertion section supporting member, elongate member and bore correspond to those
3 discussed above in relation to the first nine aspects of the invention.

4
5 Description of the Drawings

6
7 An example embodiment of the present invention will now be illustrated with reference to the
8 following Figures in which:

9
10 Figure 1 is an orthogonal view from a lateral position of a laryngoscope insertion section
11 according to the present invention;

12
13 Figures 2 to 4 are perspective views from a range of orientations of the laryngoscope
14 insertion section of Figure 1;

15
16 Figure 5 is an orthogonal view from a lateral position of the laryngoscope insertion section of
17 Figure 1 detachably retaining an endotracheal tube with a diameter at the upper end of an
18 operating range of endotracheal tube sizes;

19
20 Figures 6 is a series of cross-sections through the insertion section and retained
21 endotracheal tube of Figure 5 along cut lines A-A, B-B, C-C and D-D;

22
23 Figure 7 is a series of cross-sections through an alternative insertion section and retained
24 endotracheal tube along cut lines equivalent to A-A, B-B, C-C and D-D of Figure 1;

25
26 Figure 8 is a series of cross-sections through a further insertion section and retained
27 endotracheal tube along cut lines equivalent to A-A, B-B, C-C and D-D of Figure 1;

28
29 Figure 9 is a series of cross-sections through a still further insertion section and retained
30 endotracheal tube along cut lines equivalent to A-A, B-B, C-C and D-D of Figure 1;

31
32 Figure 10 is an orthogonal view from a lateral position of the laryngoscope insertion section
33 of Figure 1 detachably retaining an endotracheal tube with a diameter at the upper end of an
34 operating range of endotracheal tube sizes;

Figure 11 is an orthogonal view from a lateral position of the laryngoscope insertion section of Figure 1 detachably retaining an endotracheal tube with a diameter at the lower end of an operating range of endotracheal tube sizes; and

Figure 12 corresponds to Figure 10 including indications of the centre lines of the retained endotracheal tube and the insertion section.

Detailed Description of an Example Embodiment

With reference to Figures 1 to 5, a laryngoscope insertion section for use with adult humans, shown generally as 1, comprises an elongate member 2 which extends from the proximal end of the insertion section 4 but does not extend as far as the distal end of the insertion section 6. The elongate member has a light-permeable viewing port 8 at its distal end. An elongate bore 10 extends along the elongate member from the proximal end of the elongate member for receiving and retaining an insertion section retaining protrusion of a laryngoscope and covering the insertion section retaining protrusion to protect it from bodily fluids in use. A retaining portion 12, which includes a fixing aperture 14 for engaging with a corresponding protrusion on an insertion section supporting member of a laryngoscope, facilitates the removable attachment of the insertion section to a laryngoscope. The insertion section may be used with a laryngoscope including a insertion section retaining member with a video camera and light source which is included in the insertion section retaining member, so that light from the light source can illuminate a patient's trachea and the surrounding region and the video camera can relay images of the patient's trachea and the surrounding region to a display. A broad protrusion 16 extends from the end of the elongate member, which functions as a blade for contacting and typically lifting a patient's anatomy in use to provide clear access to the larynx.

A tube guide extends laterally of the elongate member. The tube guide comprises a distal superior tube guiding member 18, located towards the distal end of the insertion section, which extends from the superior side of the elongate member and functions as the first superior tube guiding member. The inferior surface of the distal superior tube guiding member includes a tube guiding surface 20 which is arranged to contact and thereby guide the superior surface of a retained endotracheal tube. A lateral edge 22 of the elongate member does not function as the tube guiding surface as, although it may contact an endotracheal tube in use, it does not contact and thereby guide the superior surface of a retained endotracheal tube.

1 The tube guide also comprises a proximal superior tube guiding member 24, located towards
2 the proximal end of the insertion section, which extends laterally from the elongate member
3 and functions as the second superior tube guiding member. The inferior surface of the
4 proximal superior tube guiding member also includes a tube guiding surface which is
5 arranged to contact and thereby guide the superior surface of a retained endotracheal tube.

6
7 The tube guiding surfaces of the proximal and distal superior tube guiding members are
8 generally incurvate. The proximal and superior tube guiding members are of generally even
9 thickness and extend laterally and superiorly from the elongate member, from a location on
10 the lateral side of the elongate member which is near to but not level with the superior
11 surface 25 of the elongate member. They extend superiorly to the superior surface of the
12 elongate member, curve over a retained endotracheal tube in use and then curve laterally
13 and inferiorly to extend over and guide the superior surface of a retained endotracheal tube.
14 The tube guiding surface of the proximal superior tube guiding member extends superiorly
15 relative to the insertion section towards its distal end. The tube guiding surface of the distal
16 superior tube guiding member extends inferiorly relative to the insertion section towards its
17 distal end. This arrangement facilitates the retention of an endotracheal tube with a greater
18 curvature than the insertion section.

19
20 An inferior tube guiding member 26 extends from a location which is distal of the proximal
21 superior tube guiding member towards the distal end of the insertion section. The inferior
22 tube guiding member comprises a tube guiding surface which is arranged to contact and
23 thereby guide the inferior surface of a retained endotracheal tube. The inferior tube guiding
24 member tapers at a proximal end and so it also comprises an inferior surface portion 28
25 which does not function as a tube guiding surface because it does not contact and thereby
26 guide the inferior surface of a retained endotracheal tube in use.

27
28 The tube guiding surfaces of the inferior tube guiding member is also generally incurvate.
29 The inferior tube guiding member is of generally even thickness and extends laterally and
30 inferiorly from the elongate member, from a location on the lateral edge of the elongate
31 member which is near to but not level with the inferior surface 25 of the elongate member.
32 The inferior tube guiding member extends inferiorly to the inferior surface of the elongate
33 member, curves over a retained endotracheal tube in use and then curves laterally and
34 superiorly to extend under and guide the inferior surface of a retained endotracheal tube.

35
36 The tube guide is arranged to leave the inferior and superior surfaces of a retained
37 endotracheal tube exposed along a majority of the length of the insertion section between the

most proximal and most distal locations where the endotracheal tube contacts a retained endotracheal tube. In an insertion section for use with adult humans, the length of the proximal superior tube guiding member, along its most superior region, may be approximately 22mm and the length of the distal superior tube guiding member, along its most superior region, may be approximately 15mm. The distance between the distal end of the proximal superior tube guiding member and the proximal end of the distal superior tube guiding member, following the curve of the insertion section, between the most superior regions of the proximal and distal superior tube guiding members, may be approximately 68mm, or 65mm in a direct line. The distance between the proximal end of the inferior tube guiding member and the distal end of the proximal superior tube guiding member may be approximately 25mm and the inferior tube guiding member may extend approximately 45mm proximally of the proximal end of the distal superior tube guiding member.

The inferior tube guiding member and the distal superior tube guiding member are arranged to guide a retained endotracheal tube 29 towards a patients' trachea in use. The tube guiding surfaces of the proximal and distal superior tube guiding members are spaced apart because the proximal and distal superior tube guiding members are spaced apart. The superior surface of a retained endotracheal tube is exposed between the tube guiding surfaces of the proximal and distal superior tube guiding members. The inferior tube guiding member extends proximally of the distal superior tube guiding member and so there is a region where a retained endotracheal tube is guided on its inferior side but not its superior side. The proximal end 30 of the tube guiding surface inferior tube guiding member is spaced apart from the distal end 32 of the proximal superior tube guiding member, by a sufficient distance to enable a 12.3mm external diameter endotracheal tube (being the upper end of an operating range of endotracheal tube sizes) to be introduced at an angle to the centre line of the insertion section.

Figure 6 comprises a series of cross-sections through the insertion section of Figure 5 along cut lines A-A, B-B, C-C and D-D. Note that in this arrangement the superior surface of the proximal superior tube guiding member is substantially in line with the superior surface of the elongate member (A-A) and the endotracheal tube (which has a diameter of 12.3mm) has a superior surface which extends superiorly of the superior surface of the adjacent elongate member (C-C). Level with the distal superior tube guiding member (D-D), the inferior surface of the inferior tube guiding member extends further in an inferior direction than the inferior surface of the elongate member. Furthermore, level with the distal superior tube guiding member, the superior surface of the distal superior tube guiding member extends further in a superior direction than the superior surface of the elongate member.

Figure 7 comprises a series of cross-sections through an alternative insertion section along cut lines which are equivalent to A-A, B-B, C-C and D-D. In this embodiment, the inferior tube guiding member is not incurvate but has an inferior surface which is level with the inferior surface of the elongate member and the superior surface of the distal superior tube guiding member extends superiorly of the superior surface of the elongate member. The superior surface of the proximal superior tube guiding member extends further in a superior direction than the superior surface of the elongate member (A-A). At the proximal end of the inferior tube guiding member, the inferior surface of the a retained endotracheal tube with 12.3mm diameter extends further in an inferior direction than the inferior surface of the elongate member. Further along the inferior tube guiding member, the inferior surface of the inferior tube guiding member extends inferiorly of the inferior surface of the elongate member.

Figure 8 comprises a series of cross-sections through an alternative insertion section along cut lines which are equivalent to A-A, B-B, C-C and D-D. In this embodiment, no proximal superior tube guiding member is provided (A-A). The inferior tube guiding member extends further inferiorly than in the previous embodiments to facilitate smooth insertion of the tube when it is pushed along its length by an intubator (C-C). The lateral surface of the elongate member comprises a slight elongate groove (B-B) to better retain an endotracheal tube within the tube guide. Level with the proximal half of the distal superior tube guiding member (C-C), the inferior surface of the inferior tube guiding member extends further in an inferior direction than the inferior surface of the elongate member. Furthermore, level with the proximal half distal superior tube guiding member, the superior surface of the distal superior tube guiding member extends further in a superior direction than the superior surface of the elongate member. The superior tube guiding member extends distally of the inferior tube guiding member as illustrated at cross-section D-D.

The various cross-sections illustrated in Figures 6 to 8 may be combined in any combination to form a range of insertion sections.

Figure 9 comprises a series of cross-sections through a still further alternative insertion section along cut lines which are equivalent to A-A, B-B, C-C and D-D. In this embodiment, which has especially reduced bulk, the elongate member is narrower and the tube guiding members extend significantly further in an inferior or superior direction, as appropriate, than the adjacent corresponding surface of the elongate member. At cross section B-B, the retained 12.3mm endotracheal tube extends superiorly and inferiorly of the superior and

1 inferior surfaces of the elongate member respectively. Accordingly, there is a region of
2 insertion section, between the proximal distal superior tube guiding member and the proximal
3 end of the tube guiding surface of the inferior tube guiding member where the thickness of
4 the insertion section is less than the thickness of the adjacent 12.3mm endotracheal tube. At
5 this location, and proximal of the proximal superior tube guiding member the thickness of the
6 elongate member may be less than 8mm and perhaps as thin as 3mm or 4mm.

7
8 The insertion section is typically moulded in one piece from a transparent plastics material
9 and supplied sterilised within a sealed package.

10
11 In use, the insertion section is detachably mounted on an elongate insertion section
12 supporting member (not shown) which fits snugly within the bore. The elongate insertion
13 section supporting member is typically attached to the handle of a laryngoscope body. A
14 video camera, functioning as imaging apparatus and a light emitting diode, functioning as
15 light source, are located on the distal tip of the elongate insertion section supporting member,
16 such that they are adjacent to the window in use. Electric wires run down the length of the
17 elongate insertion section supporting member which supply power to the video camera and
18 light source.

19
20 The elongate strengthening section is typically fabricated from steel or another rigid material.
21 As well as supporting the video camera and light source and enclosing the electrical
22 connections to the video camera and light source, the elongate strengthening section
23 functions to provide support the insertion section, enabling it to be thinner than would
24 otherwise be the case.

25
26 Once the insertion section has been attached to a laryngoscope body, an endotracheal tube
27 within an operating range of endotracheal tube sizes which can be used reliably with the
28 insertion section is inserted into the tube guide, in contact with the tube guiding surfaces of
29 the inferior tube guiding member and the proximal and distal tube guiding members. For an
30 insertion section for use in the intubation of human adults, a suitable operating range of
31 external tube diameters would be 8mm to 12.3mm.

32
33 The laryngoscope with insertion section is then introduced into a patient, the blade is used to
34 contact, and perhaps lift, the patient's anatomy to obtain clear access to the larynx. The light
35 emitting diode illuminates the patient's laryngeal area whilst images from the video camera
36 are relayed to a display which might be an integral part of the laryngoscope or may be
37 separate to the laryngoscope. The laryngoscope is inserted fully into a patient, i.e. to the

1 point where an anaesthetist would consider it to be optimally aligned for the introduction of an
2 endotracheal tube. The endotracheal tube is then advanced forward through the insertion
3 section into the patient's larynx. Once the tube has been successfully inserted, it can be
4 detached laterally from the insertion section and separated from the insertion section in situ.
5 The insertion section can then be removed and the endotracheal tube left in place.

6
7 Note that endotracheal tubes will be retained within the tube guide under flexural tension.
8 Although endotracheal tubes typically have an inherent curvature, the retained endotracheal
9 tubes will be subject to bending forces in the inferior direction at both the proximal and distal
10 superior tube guiding member and a force in the superior direction at at least a portion of the
11 inferior tube guiding member. Endotracheal tubes are resilient and so they exert a force 42 in
12 a superior direction on at least the distal ends of the proximal and distal superior tube guiding
13 members and a further force 44 in an inferior direction on at least a region of (typically
14 towards or at the proximal end) the inferior tube guiding member. This improves the grip of
15 the tube guiding members on a retained endotracheal tube enabling the tube guiding
16 members to have lower profiles and to extend less far around retained endotracheal tubes
17 than would otherwise be the case, facilitating the provision of a reliable laterally opening tube
18 guide.

19
20 In practice, retained endotracheal tubes of at least some diameters (typically at the upper end
21 of the operating range of endotracheal tube sizes) will typically contact the tube guiding
22 surface of the proximal and distal superior tube guiding members only at the distal ends of
23 these tube guiding members, due to the curved path of the retained tube, whilst the
24 endotracheal tube is at rest within the guide. Other tube guiding surfaces of the proximal and
25 distal superior tube guiding members are relevant during the stage of inserting an
26 endotracheal tube into the tube guide, although they could conceivably be omitted. Similarly,
27 such endotracheal tubes will typically only contact the tube guiding surface of the inferior tube
28 guiding member towards the proximal end of the tube guiding surface, again due to the
29 curved path of the retained endotracheal tube. This arrangement, in which the endotracheal
30 tubes only contact a limited region of some or all of the tube guiding members reduces
31 friction when the endotracheal tube is advanced into a patient's trachea.

32
33 The insertion section has a number of key advantages which result from features of the
34 design. Firstly, the insertion section is adapted to minimise the risk of damaging a patient's
35 teeth and to facilitate the manoeuvrability of the insertion section in the region of a patient's
36 teeth as there is a substantial narrow region 34, functioning as the first region, where the
37 thickness of the insertion section is less than the external diameter of the largest size of

1 endotracheal tube in an operating range of endotracheal tubes (12.3mm in this example) plus
2 the thickness of the inferior tube contacting member where it contacts the inferior surface of a
3 retained endotracheal tube (at least 0.75mm and typically 1.5mm) plus the thickness of the
4 distal superior tube contacting member where it contacts the superior surface of a retained
5 endotracheal tube (at least 0.75mm and typically 1.5mm). Although the narrow region
6 extends along the majority of the length of the insertion section in this example, it would be
7 useful to provide a narrow section with a thickness which is less than the abovementioned
8 thickness, even if it only extended along a short portion of the insertion section, such as along
9 a length of 2cm, 1cm or even 0.5cm of the insertion section, close to a patient's teeth when
10 the insertion section is fully inserted into a patient of typical dimensions.

11
12 One feature which enables the thickness of the tube guide to remain less than the said
13 thickness (15.3mm in the present example) proximal of the distal superior tube contacting
14 member is the arrangement in which the tube guiding surfaces of the proximal and distal
15 superior tube contacting members are spaced apart, leaving the superior surface of a
16 retained endotracheal tube exposed. The presence of an inferior tube guiding member and a
17 distal superior tube guiding member is sufficient to guide the tube. However, the
18 arrangement in which the inferior tube guiding member extends proximally of the tube guiding
19 surface of the distal superior tube guiding member and there is a region where the superior
20 surface of a retained tube is left exposed opposite a first region of tube guiding surface of the
21 inferior tube guiding member, has the benefit that a retained tube can be accurately guided
22 by the inferior tube guiding member but the bulk of the insertion section is reduced by the
23 omission of the a tube guiding member opposite the said region of the inferior tube guiding
24 member.

25
26 Similarly, as no tube guiding surface is provided opposite the tube guiding surface of the
27 proximal superior tube guiding member, the thickness of the tube guide remains less than the
28 said thickness (15.3mm in the present example) close to a patient's teeth in use.

29
30 There is a region between the distal end of the tube guiding surface of the proximal superior
31 tube guiding member and the proximal end of the tube guiding surface of the inferior tube
32 guiding member where a retained endotracheal tube is exposed on both its inferior and
33 superior surfaces. This is advantageous firstly in that the overall bulk of the insertion section
34 has been reduced by omitting tube guiding members in this region. This enables the inferior
35 tube guiding member and a projection of the superior tube guiding member to be spaced
36 apart by less than the external diameter of an endotracheal tube at the top end of an
37 operating range of tube sizes (12.3mm external diameter in the present example).

Furthermore, this arrangement facilitates the introduction of an endotracheal tube at the top end of an operating range of tube sizes at an angle to the length of the insertion section. This is best illustrated in Figure 12 where it will be seen that the centre line 36 of the retained 12.3mm endotracheal tube has a greater radius of curvature than the centre line of the insertion section 38 and, indeed, the most superior point on the retained endotracheal tube is superior of the superior surface of the insertion section. Thus, the endotracheal tube extends into the volume which would be occupied by a superior tube guiding member if the superior tube guiding member had extended to the proximal end of the inferior tube guiding member. Accordingly, the insertion section is thinner from the proximal superior tube guiding member to the distal superior tube guiding member than would have been the case if the tube guide covered both the inferior and superior surface of a retained endotracheal tube along this length. An endotracheal tube at the bottom end of the operating range of endotracheal tube sizes might alternatively have a smaller radius of curvature and may not contact the inferior tube guiding member.

It is also notable that the thickness of the tube guide is greater level with the distal superior tube guiding member than the thickness of the adjacent elongate member. Furthermore, the superior surface of the distal superior tube guiding member extends further in a superior direction than the superior surface of the adjacent elongate member and the inferior surface of the inferior tube guiding member extends further in an inferior direction than the inferior surface of the elongate member adjacent to the inferior tube guiding member. Accordingly, the overall bulk of the insertion section is less than would be the case if the inferior and superior surfaces of the tube guiding members extended level with the inferior and superior surfaces respectively of the elongate member, along the entire length of the insertion section. This substantially reduces the overall bulk of the insertion section, facilitating rapid intubation.

The maintenance of a retained endotracheal tube in a curved path is facilitated by the provision of a distal superior tube contacting member which has an inferior tube guiding surface which is at an angle to the centre line of the insertion section, such that it extends inferiorly towards its distal end. Similarly, the proximal superior tube contacting member has an inferior tube guiding surface which is at an angle to the centre line of the insertion section, such that it extends superiorly towards its distal end.

In some embodiments, illustrated in Figure 7, the superior surface of the proximal superior tube guiding member extends further in a superior direction than the superior surface of the elongate member adjacent to the proximal superior tube guiding member which reduces the

1 bulk of the insertion section in the region of a patient's teeth when the insertion section is fully
2 inserted into a patient's oral cavity.

3
4 In some embodiments, illustrated in Figure 8, the proximal superior tube guiding member is
5 entirely omitted. The tube guiding surface of the inferior tube guiding member does not
6 extend to the proximal end of the insertion section. This reduces bulk further and is facilitated
7 by the provision of an inferior tube guiding member having a tube guiding surface which does
8 extend proximally of the proximal end of the tube guiding surface of the distal superior tube
9 guiding member. In some embodiments, the tube guiding surface of the distal superior tube
10 guiding member is entirely distal of the portion of the insertion section (which is typically the
11 most curved) which extend around the base of a patient's tongue in use. However, in the
12 embodiment illustrated in Figure 8, the tube guiding surface of the distal superior tube
13 contacting member does extend to the portion of the insertion section which extends around
14 the base of a patient's tongue in use.

15
16 In the embodiment of Figure 9, the thickness of the elongate member is significantly reduced,
17 to less than the external diameter of the largest endotracheal tube in the operating range of
18 endotracheal tubes, to further reduce the overall bulk of the insertion section.

19
20 A further benefit of arranging the tube guide such that a retained endotracheal tube remains
21 curved between the proximal end of the insertion section and the distal superior tube guiding
22 member is that, in contrast to J-shaped insertion sections with tube guides, the insertion
23 section can be more naturally introduced into a patient's oral cavity along a curved path. In
24 contrast, J-shaped insertion sections require to be tilted backwards and forward as they
25 inserted in a multi-stage process. Furthermore less force would be required to advance the
26 retained tube into a patient's trachea than with a J-shaped tube guide, where significant force
27 would be exerted on the tube guide where the straight portion began to curve. Endotracheal
28 tubes are typically slightly curved and this arrangement facilitates convenient use of slightly
29 curved endotracheal tubes.

30
31 As a result of the design features which reduce the overall bulk of the insertion section, the
32 insertion section can be made of a size to work with larger diameter endotracheal tubes. For
33 example, an insertion section which can be easily used for rapid insertion of a tube in difficult
34 intubation situations can be provided which can be used with endotracheal tubes with a
35 diameter of up to 12.3mm.

1 Alternative insertion sections may be provided for use with infant humans, or specific animals
2 or groups of animals, such as horses. In this case, the insertion section may be scaled
3 proportionately. The length, width and thickness of the insertion section as a whole are
4 typically scaled proportionately. Nevertheless, some dimensions, such as the thickness of
5 the tube guiding members, may not be scaled proportionately.

6
7 It will be seen that the tube guide has been arranged to retain an endotracheal tube laterally
8 of the elongate member, fitting better with the general shape of a patient's oral cavity than a
9 tube guide which retain an endotracheal tube inferiorly or superiorly of the insertion section.

10
11 Although the illustrated embodiments show proximal and distal superior tube guiding
12 members which finish abruptly so that the tube guiding surfaces of the proximal and distal
13 superior tube guiding members terminate at the proximal and distal ends of each superior
14 tube guiding member, either or both of the proximal and distal superior tube guiding members
15 could instead taper and include portions which did not function as tube guiding surfaces
16 which contact and thereby guide the superior surface of a retained endotracheal tube. For
17 example, a lip extending from the elongate member may connect the proximal and distal
18 superior tube guiding members, but not affect the function of the invention because the lip
19 does not constitute a tube guiding surface within the meaning of the present invention.

20
21 Although the invention has been illustrated using a detachably retainable insertion section
22 portion, the insertion section may alternatively be an integral part of a laryngoscope.

23
24 Further modifications and variations may be made within the scope of the invention herein
25 disclosed.

Claims

1. An elongate laryngoscope insertion section having a proximal end and a distal end for insertion into a patient's oral cavity in use, the insertion section comprising a tube guide for removably retaining an endotracheal tube and guiding a retained endotracheal tube towards a patient's larynx and an elongate member, wherein the tube guide comprises a plurality of tube guiding members which extend laterally of the elongate member and have tube guiding surfaces which are arranged to contact and thereby guide the inferior or superior surface of a retained endotracheal tube, the plurality of tube guiding members comprising at least an inferior tube guiding member having a tube guiding surface on a superior side thereof for contacting and thereby guiding the inferior surface of a retained endotracheal tube, and a first superior tube guiding member having a tube guiding surface on an inferior side thereof for contacting and thereby guiding the superior surface of a retained endotracheal tube, wherein, at at least one location along the length of the insertion section, the thickness of the elongate member is less than the thickness of the adjacent tube guide.
2. An elongate laryngoscope insertion section according to Claim 1, wherein the insertion section is configured such that, at the said at least one location, the thickness of the elongate member is less than the thickness of the adjacent tube guide plus the external diameter of a retained endotracheal tube having the largest external diameter in the operating range of endotracheal tube external diameters.
3. An elongate laryngoscope insertion section according to any one preceding Claim, wherein at at least one location where the tube guide comprises a superior tube guiding member, the superior tube guiding member extends further in a superior direction than the elongate member, adjacent to the superior tube guiding member.
4. An elongate laryngoscope insertion section according to any one preceding Claim, wherein at at least one location where the tube guide comprises an inferior tube guiding member, the inferior tube guiding member extends further in an inferior direction than the elongate member, adjacent to the inferior tube guiding member.
5. An elongate laryngoscope insertion section according to any one preceding Claim, wherein, at at least one location proximal of the tube guiding surface of the first superior tube guiding member, the insertion section is arranged such that a retained

1 endotracheal tube at the upper end of an operating range of endotracheal tube sizes
2 has both its inferior and superior surfaces left exposed in use.

3

4 6. An elongate laryngoscope insertion section according to any one preceding Claim,
5 wherein, at at least one location proximal of the tube guiding surface of the first
6 superior tube guiding member, the insertion section is arranged such that a retained
7 endotracheal tube at the upper end of an operating range of endotracheal tube sizes
8 extends inferiorly and superiorly of an adjacent section of elongate member.

9

10 7. An elongate laryngoscope insertion section according to any one preceding Claim
11 wherein, at at least one location proximal of the tube guiding surface of the first
12 superior tube guiding member, the thickness of the insertion section is less than
13 three-quarters of the diameter of the largest external diameter endotracheal tube in an
14 operating range of endotracheal tube sizes.

15

16 8. An elongate laryngoscope insertion section according to any one preceding Claim,
17 suitable for use with a retained endotracheal tube having an external diameter
18 substantially in the range between 5.5mm and 12.3mm.

19

20 9. An elongate laryngoscope insertion section according to any one preceding Claim,
21 suitable for use with a retained endotracheal tube having an external diameter
22 substantially in the range between 1.0mm and 5.0mm.

23

24 10. A laryngoscope comprising a handle, and an insertion section according to any one
25 preceding Claim.

26

27 11. A laryngoscope according to Claim 10, wherein the insertion section is fixedly
28 attached to the handle.

29