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THERMAL MATERIAL NEBULIZING SYSTEM WITH ANIMAL MASK

Abstract

A system for thermal regulation of a nebulizer is provided that is structured to deliver a chilled mist to the snout, muzzle, beak, or trunk of an animal. The system includes a container to house a nebulizer and a thermal material together and a mask to deliver the chilled mist to an animal. The thermal material acts to chill a liquid located inside the nebulizer in order to deliver a chilled mist to the animal for therapeutic purposes, such as initiating therapeutic hypothermia, or treating various respiratory illnesses such as croup, laryngobronchitis, and smoke inhalation.

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Background/Summary

BACKGROUND

Technical Field

[0001] The present disclosure relates to devices for atomizing liquid and, more particularly, to a noninvasive portable apparatus and system that utilizes a thermal medium to chill atomized liquid into a stream of chilled mist during nebulization and delivers the chilled mist to an animal.

Description of the Related Art

[0002] Nebulizers are commonly found in the healthcare industry for delivery of atomized mist to a patient. Nebulizers hold a prescribed amount of liquid medication or saline that is then atomized for inhalation. The medication used will vary, depending on the needs of the patient, which can range from Albuterol for Asthma to Racemic Epinephrine for Croup. Nebulizers utilize a variety of technologies to atomize the solutions being inhaled, such as jet nebulizers, High Density Jet Nebulizers, ultrasonic wave nebulizers, and ultrasonic vibrating mesh technology among others. These methods all produce a room temperature mist delivered to the patient's airway, usually particles fewer than 5 micrometers for better delivery to the patient's airway.

[0003] Nebulizers are used for a variety of conditions including but not limited to Croup, RSV, Epiglottitis, Allergic Reactions, Bronchospasm, Laryngitis, Pneumonia, Asthma, COPD, Bronchitis, Sepsis, ventilated patients, and smoke/heat/blast inhalation patients. They are commonly used by Emergency Medical Services (EMS) Pre-Hospital, ambulance, medical flight crews in aircraft, in Emergency Departments, ICU's, CCU's, Operating rooms, Recovery rooms, Medical and Surgical units, Respiratory Therapy for both in and out patients, Medical Short Stay units, doctors' offices, urgent care clinics, Home Health, Military Medical personal in military hospitals, field hospitals, and front line medic treatment, Wilderness expedition medical crews, World Outreach Medical Teams, individual patients in their homes and by Veterinarians in Animal Hospitals, Zoos, Clinics, and in Outpatient settings.

[0004] Chilled liquid nebulized into mist can have beneficial effects on the patient and can be more comfortable for the patient. Chilled liquid nebulized into mist can act to reduce swelling and irritation of the larynx and upper respiratory tract due to illness such as croup, bronchitis, allergic reaction, smoke inhalation and other airway compromised patients. Chilled liquid nebulized into mist can act to initiate Therapeutic Hypothermia and treat other heat related illness.

[0005] Attempts have been made to chill breathable gases in the past, for example those of U.S. Pat. No. 6,536,423 (“Conway”), U.S. Pat. No. 6,997,184 (“Donohue”), U.S. Pat. No. 7,201,163 (“Jiang et al”) and U.S. patent application Ser. No. 11/899,110 (“Carrier”). However, these attempts have all failed to produce an adaptable, ergonomic, highly portable, simple way to produce chilled mist nebulized from chilled liquid. For example, Conway uses a complicated mist producing apparatus that requires a constant power supply and is not compatible with standard nebulizers. Donohue cannot interface with a nebulizer and, therefore, cannot chill the fine mist produced by a nebulizer. Furthermore, Donohue chills the air that is breathed in immediately prior to breathing in, which may cause significant condensation of any fine particles contained in the air, significantly reducing the benefits of breathing fine particles. Similarly, Jiang et al uses a complex heat exchanger in order to chill or heat the mist and is not compatible with standard nebulizers in a portable manner. Carrier also does not interface with a standard nebulizer, and his device produces the chilling effect immediately prior to inhalation, which can cause the condensation issues described above. Carrier also involves a number of separate pieces that must be placed together in order to use the device, greatly reducing simplicity and ease of use.

[0006] Moreover, these designs require complicated processes and setups, and none are readily compatible with standard small-volume nebulizers, therefore requiring additional costly devices. There is a need, therefore, for a simple, ergonomic solution to chill the nebulized mist coming from a standard nebulizer, without requiring expensive or complicated systems. Such a solution should address the need for rapid reduction of airway edema, irritation, and/or inflammation in patients with Epiglottis, Croup, RSV, Bronchospasm, Fever, Allergic Reaction, Smoke Inhalation, Blast Injury, Asthma, Bronchitis, Pneumonia, Laryngitis, Sepsis, COPD, ventilated patients, and pre and post ENT surgery, as well as provide for core cooling during CPR. Moreover, there is a need for rapid initiation of Therapeutic Hypothermia for patients post Cardiac Arrest or acute brain insult. Furthermore, there is a need for Targeted Temperature Management (TTM).

BRIEF SUMMARY

[0007] In accordance with one embodiment of the present disclosure, a thermal nebulizing system is disclosed. The thermal nebulizing system includes a device that has a container with an interior, an input port in fluid communication with the interior, a nebulizer in the interior of the container and coupled to the input port, a conduit coupled to the nebulizer and configured to deliver a mist from the nebulizer to the exterior of the container, and a lid configured to cover the container. The interior is configured to accept a thermal material for cooling. The device includes a delivery apparatus coupled to the conduit that includes a mask having a body with an interior chamber and a cap with radially oriented flaps that are capable of bending inward into the interior chamber, the interior chamber sized and shaped to accommodate the muzzle, snout or beak of an animal.

[0008] In another embodiment, the device has a thermal material configured to chill a liquid; a source configured to deliver at least one of oxygen or compressed air to the nebulizer; and a delivery mechanism configured to interface with a recipient and deliver chilled nebulized mist from the nebulizer to the recipient. In a further embodiment, the thermal material is an evaporative material.

[0009] In accordance with one aspect of the present disclosure, a device is provided that includes a container having at least a side wall and a bottom wall configured to define an open interior and an open top in communication with the interior, and an input port in the bottom wall or the side wall that is in fluid communication with the interior; a nebulizer located in the interior of the container and coupled to the input port for fluid communication; a lid configured to cover the open top and provide fluid communication with the interior of the container; and a conduit coupled to the lid and the nebulizer and configured to deliver a chilled mist from the nebulizer through the access tube extending through the lid to an exterior of the container.

[0010] In accordance with another aspect of the present disclosure, the device includes a nipple extending through the container input port and into the interior of the container, the nipple coupled to an input of the nebulizer and sized and shaped to provide fluid communication between the input port and the input of the nebulizer and to position the nebulizer above the bottom wall of the container.

[0011] In accordance with still yet another aspect of the present disclosure, a system is provided

that includes a thermal material configured to chill a liquid; a nebulizing device; a hand-holdable container having an interior sized and shaped to receive the nebulizing device and configured to store the thermal material around the nebulizing device; a source configured to deliver at least one of oxygen or compressed air to an input of the nebulizing device; and a delivery apparatus operably coupled to an output of the nebulizing device and configured to interface with a recipient and deliver chilled nebulized mist from the nebulizing device to the recipient.
[0012] Ideally, the system includes a conduit extending through the container and into the interior of the container, the conduit coupled to the input of the nebulizing device and sized and shaped to provide fluid communication between the source and the input of the nebulizing device and to hold the nebulizing device above the bottom wall of the container.
[0013] In accordance with still yet a further aspect of the present disclosure, a thermal material nebulizing and delivery apparatus is provided that includes a nebulizer having a fluid input and a fluid output and configured to hold a liquid; thermal material; a container configured to hold the thermal material and the nebulizer, the container having an interior and an input port and an open top in fluid communication with the interior and the input port; a cover configured to close the open top and having an opening structured to provide fluid communication with the interior; and a conduit mounted in the opening of the cover and coupled to the nebulizer and configured to deliver a chilled mist from the nebulizer through the lid and to an exterior of the container.
[0014] Ideally, the apparatus includes a conduit extending through the container and into the interior of the container, the conduit coupled to the input of the nebulizing device and sized and shaped to provide fluid communication between the source and the input of the nebulizing device and to hold the nebulizing device above the bottom wall of the container.
[0015] In accordance with a further aspect of the present disclosure, the container is configured to hold the nebulizer in the interior and the container is configured to hold the thermal evaporative material in the interior surrounding the contained nebulizer. Alternatively, the container includes a double-walled portion having an interior space configured to hold the thermal material.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS
[0016] The foregoing and other features and advantages of the present disclosure will be more readily appreciated as the same become better understood from the following detailed description when taken in conjunction with the accompanying drawings, wherein:
[0017] FIG. **1** is an isometric view of a thermal nebulizing device that includes a delivery mechanism according to one embodiment of the present disclosure;
[0018] FIG. **2** is a partially exploded isometric view of the device of FIG. **1**;
[0019] FIG. **3** is an isometric view of a container and cap of the device of FIG. **1**;
[0020] FIG. **4** is an isometric view of a thermal nebulizing device that includes a mouthpiece attached to a connector according to one embodiment of the present disclosure;
[0021] FIG. **5** is a partially exploded isometric view of the nebulizing device of FIG. **4**;
[0022] FIG. **6** is a partially exploded isometric view of a thermal nebulizing device with handles according to one embodiment of the present disclosure;
[0023] FIG. **7** is an isometric view of a thermal nebulizing device utilizing a thermal evaporative material according to one embodiment of the present disclosure;
[0024] FIG. **8** is an isometric view of a thermal nebulizing device that includes a mask configured to be used with animals or birds according to one embodiment of the present disclosure;
[0025] FIG. **9** is an isometric view of the nebulizing device of FIG. **8** illustrating an animal using the nebulizing device;
[0026] FIG. **10** is an isometric view of a mask being used with an animal according to one

embodiment of the present disclosure;
[0027] FIG. **11** is an enlarged isometric view of the mask of FIG. **10**;
[0028] FIG. **12** is an isometric view of a thermal nebulizing device that includes a mask to attach to a recipient's face according to one embodiment of the present disclosure;
[0029] FIG. **13** is a partially exploded view of the nebulizing device of FIG. **12**;
[0030] FIG. **14** is an isometric view of the nebulizing device of FIG. **12** shown being used by a child;
[0031] FIG. **15** is an isometric view of a thermal nebulizing device with a pacifier mist delivery device according to one embodiment of the present disclosure;
[0032] FIG. **16** is an isometric view of a thermal nebulizing device having a dual port T-connector and supply tubing according to one embodiment of the present disclosure;
[0033] FIG. **17** is an isometric view of the nebulizing device of FIG. **16** illustrating a dual-port embodiment in which one end of the T-connector is blocked off according to one embodiment of the present disclosure;
[0034] FIG. **18** is a chart illustrating five mist cooling configurations for the Thermal Nebulizing System;
[0035] FIG. **19** is an pictorial view illustrating a doubled wall configuration of the thermal nebulizing container in accordance with another aspect of the present disclosure; and
[0036] FIG. **20** is a partial cut-away isometric view illustrating the doubled wall configuration of the thermal nebulizing container of FIG. **19**.

DETAILED DESCRIPTION

[0037] In the following description, certain specific details are set forth in order to provide a thorough understanding of various disclosed embodiments. However, one skilled in the relevant art will recognize that embodiments may be practiced without one or more of these specific details, or with other methods, components, materials, etc. In other instances, well-known structures or components or both associated with the nebulizing system, including but not limited to the oxygen or air compressor have not been shown or described in order to avoid unnecessarily obscuring descriptions of the embodiments.
[0038] Unless the context requires otherwise, throughout the specification and claims that follow, the word “comprise” and variations thereof, such as “comprises” and “comprising” are to be construed in an open inclusive sense, that is, as “including, but not limited to.” The foregoing applies equally to the words “including” and “having.”
[0039] Reference throughout this description to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the appearance of the phrases “in one embodiment” or “in an embodiment” in various places throughout the specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.
[0040] FIG. **1** shows a thermal nebulizing apparatus **20** configured to produce a chilled atomized mist to a patient for therapeutic purposes. The thermal nebulizing system **20** includes a container **22**, a lid **24** removably attached to the container, thermal material **26** (shown in FIG. **7**) in an interior **44** of the container **22** along with a nebulizer **28**, and a delivery mechanism **30**. The apparatus **20** also includes a T-shaped connector **32** mounted on top of an access tube **52**, and a mist delivery tube **34** configured to be coupled to the connector **32**. The thermal nebulizing system **20** provides a number of benefits to patients through the use of the container **22** and thermal material **26**. The thermal material **26** acts to cool a liquid **38** that is located in the nebulizer **28**, thereby delivering a chilled mist to the patient after nebulization.
[0041] Referring to FIGS. **1** through **3**, the container **22** is made up of a circular sidewall **40** and a bottom **42**, forming a substantially hollow interior **44**, which is accessible through an opening **46** in the container top. The interior **44** is configured to receive and house the nebulizer **28**.

[0042] In addition, the interior **44** is structured to receive and store the thermal material **26**. The bottom **42** of the container **22** has a connector nipple **48** extending from the interior **44** through to the exterior of the bottom **42**, which is structured to provide fluid communication between an interior **45** of the nebulizer **28** and the outside of the container **22**. In other embodiments the connector nipple **48** may be located so as to extend through the sidewall **40** of the container **22**, or any other suitable location to provide fluid communication between the nebulizer interior **45** and the exterior of the container **22**. In some embodiments, the connector nipple **48** may be inserted through and sealingly connected to the container **22** through a snug fitting; however, the nipple **48** may be also be sealingly connected using an adhesive, threading or any other suitable means that provides a seal between the nipple **48** and the container **22** in order to prevent air or liquid from leaking to the outside of the container **22**. The ideal embodiment would be injection molded with the nebulizer **28** a fluid part of the container **22** housed in the interior **44** accessed through the opening **46** at the top of the container **22**. The access tube **52** is formed to be in fluid communication with the nebulizer **28**.

[0043] The lid **24** is mounted on to the container **22** in order to close off the opening **46**. The lid **24** may be any shape or size, but preferably has a two-tiered convex dome configuration **49**. The lid **24** is structured to mount to the sidewall **40** of the container to remain firmly in place yet be removable. The lid **24** may attach to the sidewall **40** through a screw-type threading, or it may snap onto the container **22** using ribs or depressions on the lid **24** and sidewall **40** or by any other suitable means.

[0044] The lid **24** includes a tube opening **50** in the top of the dome to accommodate an extension tube or access tube **52**, which is configured to provide fluid communication between the nebulizer **28** and the connector **32**. The tube opening **50** in the lid **24** has a generally circular shape through which the access tube **52** can be inserted. However, in other embodiments, the tube opening **50** can be any shape and size suitable to accommodate the access tube **52**. The access tube **52** is connected to the output of the nebulizer **28** for fluid communication, and it is configured as the output conduit of the nebulizer **28** through which the atomized mist is conveyed and expelled. The access tube **52** is formed to project through the tube opening **50** and connect to a fitting **31** on the connector **32**, preferably in a slidable arrangement. The lid **24** with the tube opening **50** and access tube **52** therefore enable fluid communication between the output of the nebulizer **28** and the connector **32** while still closing off the opening **46** of the container **22** to any other fluid communication.

[0045] The thermal material **26** (shown in FIG. **7**) can be any material with thermal properties capable of inducing a cooling effect on the liquid **38** in the nebulizer **28**. The thermal material **26** may induce a cooling effect on the liquid **38**. For example, in some cases, a patient may require Therapeutic Hypothermia, in order to cool the temperature of the patient's body. In such a case, the thermal material **26** would be of a type to cool the liquid **38** in order to deliver a chilled mist to the patient. The thermal material **26** is stored in the interior **44** of the container **22**, where it thermally interacts with the liquid **38** in the nebulizer **28** in order to induce a cooling effect.

[0046] The nebulizer **28** is generally a small volume nebulizer, structured to be inserted into the interior **44** of the container **22**. Because the nebulizer **28** is readily commercially available, it will not be described in detail herein. Briefly, the nebulizer **28** can be any type of nebulizer, for example, an ultrasonic nebulizer, jet nebulizer, High Density Jet Nebulizer or vibrating mesh nebulizer, but is preferably a small volume jet nebulizer, such as those manufactured by CareFusion. Generally, the nebulizer **28** has a housing **29** that defines the interior space **45**. Typically, the housing **28** is formed of a top **31** and a bottom **33** with a fluid input **35** formed in the bottom **33**, which is in fluid communication with the interior space **45**, and a fluid output **37** formed in the top **31**, which is also in fluid communication with the nebulizer interior space **45**. The interior space **45** of the nebulizer **28** contains the liquid **38**, which is reduced to a mist of fine particles and delivered to the patient through the fluid output **37** of the nebulizer and the access tube **52**. In all embodiments, the interior space **45** of the nebulizer **28** is in fluid communication

with the connector nipple **48**. In such an embodiment, the nebulizer **28** receives a gaseous input from a gas source through the connector nipple **48**, for example, compressed air or oxygen.
[0047] As seen in FIGS. **1** and **2**, the nipple **48** extends into the interior **44** of the container **22** a short distance before coupling to the input on the bottom of the nebulizer **28**. This positions the nebulizer **28** above the container bottom **48** to be centrally disposed inside the interior **44** of the container **22**, permitting the coolant or thermal material to surround the nebulizer **28** from the bottom **33** to the top **31** thereof. This facilitates more rapid and complete cooling of the liquid **38** in the nebulizer **48** as described more fully below.
[0048] The delivery mechanism **30** is an interface through which a patient receives the therapeutic mist from the thermal nebulizing system **20**. The delivery mechanism **30** is in fluid communication with the nebulizer **28** through the connector **32**, either directly or through the tube **34**, where the tube is connected to the connector **32** on one end and the delivery mechanism **30** on the other end. In other embodiments, the delivery mechanism may connect directly to the access tube **52**. The delivery mechanism **30** is configured to enable a patient to receive the chilled atomized mist through the delivery mechanism **30**. There are a number of delivery mechanisms commercially available, such as masks, mouthpieces, endotracheal tubes and pacifier mist delivery devices, and these will not be described in more detail.
[0049] The connector **32** is generally a T-shaped connector, but could also be any other connector with two or more end openings, such as an L-shaped connector, a straight tube connector, or a Y-shaped connector. The connector **32** has generally a hollow cylindrical shape, but it could also be any other shape. The fitting **31** extends at substantially a right angle from a cross tube **33**, and both the fitting **31** and the cross tube **33** are substantially hollow to allow for air passage. The fitting **31** is structured to connect the access tube **52** to the cross tube **33** and ultimately to the delivery mechanism **30** via the flexible tube **34**. The connector **32** may also optionally include a cover **36** in order to close off one of the cross tube **33** openings.
[0050] In the partially exploded view of FIG. **2**, the thermal nebulizing system **20** is assembled by placing the nebulizer **28** inside the container **22**, placing the thermal material **26** inside the container **22** (as shown in FIG. **7**), and placing the lid **24** on the container **22** to cover the opening **46** while positioning the access tube **52** through the tube opening **50**. The connector **32** is attached to the access tube **52**, and the delivery mechanism **30** is attached to a connector, to attach to a ventilator. The container **22** may optionally also be covered in a thermally insulating sleeve in order to decrease loss of cooling ability, such as a neoprene sleeve. The nebulizer **28** is then used regularly, either with a liquid medication **38** or with sterile saline, while the patient breathes in the chilled mist through the delivery mechanism **30**.
[0051] FIG. **3** is an exploded view of the container **22** and lid **24**. The container **22** can be any suitable material, but is preferably a material with an insulating quality in order to decrease thermal losses. The container **22** is generally made of a rigid material, such as plastic, polyethylene or polycarbonate, in order to protect the nebulizer **28** and thermal material **26**. Other embodiments may use a flexible material for enhanced portability and storage ability when not in use. In some embodiments, the container is between 1.5 and 4 inches in width or diameter, and between 3 and 6 inches in height, preferably about 2.5 inches in width or diameter and about 4.5 inches in height. The opening **46** is generally about the same width as the container **22**, or it may be somewhat smaller than the width of the container. Ideally, a 20 ounce size bottle is preferred because anything smaller would not hold enough ice along with the nebulizer **28**, and anything much larger would be difficult for a child to hold. The container **22** may be transparent, translucent, or opaque.
[0052] The lid **24** is configured to entirely cover and removably attach to the container **22** at the opening **46**. The lid **24** may be attached to the container **22** in any suitable fashion, such as threading, rib to rib connection, rib to depression connection, or any other method. The tube opening **50** is configured to snugly fit the access tube **52** through the tube opening **50**, and it is generally located in the center of the lid **24**. The tube opening **50** may be of any size suitable to fit

the access tube **52**, but is preferably between 0.5 and 1.5 inches.

[0053] FIGS. **4** and **5** show the thermal nebulizing system **20** with a corrugated tube **60** and mouthpiece **62**, both of which are readily commercially available. The embodiment shown in FIG. **4** is the preferred embodiment for the typical method of use. The corrugated tube **60** is configured to removably attach to the connector **32**, while the mouthpiece **62** attaches to the other end of the connector **32**, and is used as the delivery mechanism **30**. The corrugated tube **60** allows ambient air to freely mix with the chilled nebulized mist upon delivery when desired. The corrugated tube further allows for the expiration of gases from the thermal nebulizing system **20** when necessary. The mouthpiece **62** is placed into a patient's mouth, and the nebulized mist, or oxygen enriched mist, is then inhaled by the patient through the mouthpiece. The connector **32** may also include an attachment point **64**, to which an anchor or tether can be attached to keep the corrugated tube **60** in a desired position.

[0054] FIG. **6** shows the thermal nebulizing system **20** with at least one handle **70** attached to the container **22**. The handle **70** could be place on both sides of the container **22**, or the container could have only one handle **70**. The handle could be anything suitable to make gripping the container easier, such as a D-shaped piece of rigid material. In some embodiments, the handle **70** is removable, being attached through any suitable removable means, such as a slot/insert mechanism or a hook and loop mechanism, such as Velcro. In other embodiments the handle **70** could be permanently attached to or formed to be integral with the container **22**.

[0055] FIG. **7** shows the thermal nebulizing system **20** with the thermal material **26**, in this case a thermal evaporative material **80** and a tubing **82**. The thermal evaporative material **80** is a fast evaporating material that is placed in the interior **44** of the container **22** in order to chill the liquid **38**. The evaporative material **80** could be any dry material capable of rapid evaporation to provide a cooling effect, such as evaporative material available from the Shanghai Tianjin Industry Co., Ltd. The thermal evaporative material **80** is activated by adding 30-60 mls water to 12-22 grams of dry snowflake shaped pieces of the evaporative material **80**. This allows users to chill the liquid **38** without access to power or ice, making the thermal nebulizing system **20** highly portable and mobile. The thermal evaporative material **80** can also be mixed with ice if available and desired in order to produce an even greater cooling effect.

[0056] In other embodiments, the thermal material **26** could be any suitable thermal material, such as ice, an ice and water mixture, cold water, frozen Thermal Gel Bead packs or a cold pack, such as the Dynarex Instant Cold Pack. In further embodiments, the thermal material **26** located inside the interior **44** of the container **22**, with the addition of a thermal material applied to the outside of the container, such as a cold pack wrapped around the outside of the container **22** for greater cooling effect. In other embodiments, the container **22** is configured to include a thermal material as an integrated part of the sidewall **40**, bottom **42**, or both in the form of an insulated container **22**.

[0057] The cooling temperatures of various types of thermal materials **26** used in conjunction with various delivery mechanisms **30** can be seen in the graph of FIG. **18**. In a controlled environment this device predictably chilled nebulized mist to a Celsius temperature significantly less than ambient temperature for one hour. FIG. **18** compares four types of Thermal medium for cooling liquid that is nebulized to a chilled mist. Four of the five configurations tested remained consistently under 10 degrees Celsius at the eight minute mark until termination of testing. The fifth configuration remained under 13 degrees Celsius from the five minute mark until termination of testing. All configurations indicate a slight increase in temperature when additional fluid was added to continue adequate mist production. The optional disposable insulator is a foil backed bubble wrap chosen for its lightweight yet effective insulating properties. Testing was terminated at one hour as this best reflects the longest expected transport time for the patient to a hospital or Medical Center.

[0058] Returning to FIG. **7**, the tubing **82** is configured to be connected to the connector nipple **48** to deliver a gas to the nebulizer **28**. The tubing **82** connects to the connector nipple **48** in any suitable way, such as snuggly fitting the tubing **82** over the connector nipple **48**, snuggly fitting the connector nipple **48** over the tubing **82**, or screwing the tubing **82** and connector nipple **48** together with a threading system.

[0059] As shown in the figures, the container bottom **42** is concave and has a plurality of radially oriented ridges **45**. However, the bottom **42** can be formed without the ridges **45** and, in some configurations can be flat.

[0060] The tubing can be any size sufficient to deliver the required amount of gas to the nebulizer **28**, but is preferably between ¼ inch and ¾ inch. The tubing **82** is connected to a gas source (not shown) on the opposite end from the connector nipple **48**. The gas source can supply natural air, oxygen, or other suitable compressed gas source. The gas source is preferably set to deliver gas through the tubing at 8 Liters/minute, but can be set to any desired level. The tubing can be any length suitable to connect the thermal nebulizing system **20** to the gas source, but is preferably between 3 feet and 10 feet long.

[0061] FIGS. **8-11** show the thermal nebulizing system **20** with an animal mask **90** as the delivery mechanism. The animal mask **90** can be used to deliver therapeutic nebulizing techniques to animals **103**. The animal mask **90** is configured to be placed over the mouth, snout, beak or trunk of an animal without harming the animal, in order to deliver nebulized mist to the animal's air passages. The animal mask **90** can be connected directly to the connector **32**, the access tube **52**, or it can be connected to the connector **32** via the flexible tube **34** in order to give greater reach to the mask **90**.

[0062] In the illustrated version of FIGS. **8** and **9**, the mask **90** has a circular sidewall **92**, a removable petal cap **94**, and a bottom wall **96** that together define an interior chamber **93**. The mask **90** also includes an access point **98** that is structured as an input port for fluid communication with the interior chamber **93**. The sidewall **92** can be either substantially straight, perpendicular to the bottom wall **96** and removable petal cap **94** or angled with respect to the bottom wall **96** and removable petal cap **94** to create a tapered sidewall **92**. The sidewall **92** and bottom wall **96** are preferably made of light weight, rigid material such as plastic, but can also be made of a flexible material in order to facilitate easier storage and portability. The access point **98** is preferably located in the bottom wall **96**, and is generally a hole in the bottom wall, or a hollow cylinder in the bottom wall **96** through which the animal mask **90** is connected to either the connector **32** or the tube **34**. The access point **98** is of sufficient size to connect to the connector **32** or the flexible tube **34**, either through snug fitting, a threaded screw type connection, or other suitable semi-air tight connections. Other embodiments of the access point **98** may include an L-shaped cylindrical port for direct connection to the access tube **52** or for connection to the connector **32** or tube **34**.

[0063] The removable petal cap **94** attaches to the sidewall **92** of the animal mask **90**. The petal cap **94** can be attached through any means, including, without limitation, a slip on fitting, a rib-to-rib snap fitting, rib-to-depression snap fitting, and a screw type fitting. In embodiments where the sidewall **92** is made of a flexible material, a rigid connective part may be located on the edge of the sidewall **92** in order to facilitate easier connection between the petal cap **94** and the sidewall **92**.

[0064] The petal cap is made of several flexible flaps that are arcuate-shaped petals **100**, which are connected around the outer edge of the petal cap **94** and come together near the center of the petal cap. As shown in FIG. **11**, the petals **100** are sized and shaped to leave a circular opening **95** at the center of the cap **94** that is in fluid communication with the interior chamber **93**.

[0065] The petals **100** are radially oriented and designed to bend or flex centrally inward, flexing along the connected edge, and provide a sealable opening about an animal's muzzle, beak or trunk when inserted into the animal mask **90**. When no animal is utilizing the mask **90**, the petals **100** return to a natural state, in which they are positioned roughly perpendicular to the sidewall **92**, and abut each other to substantially close off the interior of the mask **90**. The petals **100** allow for a safe, snug fit between the animal mask **90** and an animal, while keeping dust and other contaminants out of the mask **90** while not in use. The sidewall **92** or bottom wall **96**, or both, may

also contain a series of holes **102**, which are configured to enable ambient air to mix with the nebulized mist when the animal **103** is using the nebulizing system **20** and provide easy exhalation.
[0066] The animal mask **90** may also optionally contain handles **104**. The handles **104** can be either permanently fixed to the mask **90** or removably attachable to the sidewall **92** through any suitable means, such as a slot/insert mechanism or a hook and look mechanism, such as Velcro. Preferably, the handles are located on the sidewall **92**; however, they may also be located on the bottom wall **96** or petal cap **94**. The handles allow for a user to hold the animal mask **90** more comfortably, steadily and without obstructing the holes **102**.
[0067] The animal mask **90** can be made in a variety of sizes and shapes in order to be used with a variety of animals, as shown in FIG. **10**. Animal masks **90** that are of similar shape, but different size could be nested together, with smaller masks **90** inside larger masks **90**, in order to reduce the storage space necessary and increase portability and mobility of the masks **90**. The mask **90** may also include a strap or resilient filament connected to the sidewall **92** or elsewhere to aid in holding the mask **90** to the animal's head.
[0068] FIGS. **12** and **13** show the thermal nebulizing system **20** with an attached face mask **110** as the delivery mechanism **30**. The face mask **110** attaches to the thermal nebulizing system **20** through the connector **32** or may connect directly to the access tube **52**. The face mask **110** may also connect to either the access tube **52** or connector **32** through the tube **34** in order to allow for greater mobility. The face mask **110** is generally shaped to fit around the mouth and lower face of a patient, and can be held in place by a flexible, reliant one-piece strap **112**. The strap **112** connects to the face mask through any suitable means, such as using an adhesive or tying the strap on, and is used to hold the face mask **110** to the patients face without the need for the patient to perform any task in order to keep the face mask **110** on the lower face. The mask **110** also contains an access or attachment point **116**, in order to allow for connection with the nebulizer **28**. The access point **116** may be a generally circular opening in the face mask, or it can be a straight or bent hollow cylindrical tube located in the mask. The access point **116** connects to the nebulizer **28** through the access tube **52**, connector **32** or tube **34**. The face mask **110** also may contain one or more relief holes **114** that allow a patient to exhale normally and ambient air to mix with the nebulized mist. The face mask **110** can be made in a variety of sizes in order to fit a variety of patients who may require the use of the mask due to limited ability to use one of the alternate delivery mechanisms **30**.
[0069] FIG. **14** illustrates the thermal nebulizing apparatus **20** of FIG. **12** being used on a pediatric patient **111**. Pediatric patients are often unable to effectively use many of the alternate delivery mechanisms and, therefore, must utilize the face mask **110** in order to use the thermal nebulizing system **20** for a beneficial amount of time. The patient places the face mask **110** on their face and then places the strap **112** behind their head in order to hold it in place then breathes normally. Alternately, a caretaker may place the face mask **110** and strap **112** on the patient if they are unable to do so.
[0070] FIG. **15** shows the thermal nebulizing system **20** with an attached pacifier mist delivery device **120**. The pacifier mist delivery device **120** is intended for use with pediatric patients **111** in order to ease the transition into breathing in nebulized mist by using a device familiar to most pediatric patients. The pacifier mist delivery device is generally in the shape of a standard pacifier and contains an air channel that goes the length of the pacifier to allow nebulized mist to be breathed into through the nostrils of an infant **111** while using the pacifier mist delivery device **120**. The channel connects to an access point **122**, which is connected to the thermal nebulizing system **20** through a tube **34**, the connector **37** or directly to the access tube **52**.
[0071] FIG. **16** shows the thermal nebulizing system **20** with an attached corrugated tube **60** being used on a patient. The corrugated tube **60** is preferable attached to a T or Y shaped connector **32**, opposite the end where a patient **111** interfaces with the thermal nebulizing system **20**. The corrugated tube acts as a reservoir to collect various droplets contained in the mist, as well as an

exhalation point and a point for air to mix with the nebulized mist for inhalation. The corrugated tube may be bent and attached to the connector **32** in order to allow for more effective catching of debris and mist droplets. When bent, the corrugated tube **60** may bend to about 180 degrees, though other bends may be desirable. When bent, the corrugated tube **60** is generally attached to the connector **32** at the attachment point **64** through any suitable attachment mechanism **66**, such a twist tie or cable tie.

[0072] FIG. **17** shows the thermal nebulizing system **20** of FIG. **16**, in which a patient interfaces with the corrugate tube **60** to obtain the nebulized mist. The port on the opposite end of the connector **32** may optionally be plugged or covered by any suitable covering mechanism **68**, such as with tape, a patient's hand or finger, or the cover **36** (see FIG. **1**) may be used. Alternatively, the port on the opposite side of connector **32** may be left open. The corrugated tube **60** serves as a collection device, retaining any large droplets in the nebulized mist to prevent the patient from inhaling these droplets. The corrugated tube **60** can also be used to direct the flow of the mist.

[0073] The chilled mist has a number of therapeutic properties, including fast acting therapy to initiate Therapeutic Hypothermia, treatment of multiple respiratory illnesses such as croup, laryngobronchitis, and others, and can produce a more comfortable nebulized mist for patients who regularly use a nebulizer. The thermal nebulizing system **20** is particularly beneficial to emergency medical professionals: allowing earlier initiation of Therapeutic Hypothermia with the potential to drastically improve patient outcomes in cases of cardiac arrest, anoxic encephalopathy and others.

[0074] Traditionally, a number of techniques may be used to induce hypothermia, such as cooling pads, intravenous devices and intranasal wands, however, these devices are generally not used until the patient is already at a hospital or other medical facility. The thermal nebulizing system **20**, on the other hand, is capable of initiating Therapeutic Hypothermia in a mobile setting, allowing first responders to use the system **20** in order to begin life saving techniques much earlier. The thermal nebulizing system **20** also is simple enough for home use or use by medical professionals without costly and time consuming training. Furthermore, the simple design of the system allows for low costs, and thereby allows the system to be treated as a one-time use system if desired in order to improve health and safety of the system.

[0075] As will be readily appreciated from the foregoing, the device and system of the present disclosure provides a rapid, simple method to deliver chilled oxygen, mist or medication to treat, improve or reverse symptoms related to the respiratory system, heat related illness, and initiation of Therapeutic Hypothermia to alleviate illness and suffering.

[0076] It is widely accepted medical practice that the application of ice to injured tissue reduces swelling, inflammation and pain. There have been many attempts in the past to apply this practice to the respiratory system. The disclosed thermal material nebulizing system is portable and requires no electrical connection to initiate cooling once a thermal medium is chosen for the application. This thermal material nebulizing system does not require effort from the patient to initiate the mist as it is a continuous flow until the airflow is disconnected.

[0077] The historical development of Therapeutic Hypothermia (TH) dates back millennia, and has been actively used by “modern” clinical medicine for the last two hundred years. Routine use of TH has been employed in the Operating Room for the past fifty years. Numerous clinical trials have used TH to reduce the core body temperature to 32-34 degrees C. Early recognition of the need for TH and the rapid initiation of TH have improved both chances of survival and neurological outcome. Current TH treatment involves various methods to cool a patient's core temperature of 32-34 degrees C. within four hours of insult to reduce the risk of tissue damage following a period of insufficient blood flow either within the brain or the myocardium (heart attack), or throughout the body as a result of cardiac arrest. Multiple invasive methods are currently in use to maintain the core temperature within the designated range for approximately twenty-four hours.

[0078] The American Heart Association has released guidelines indicating Therapeutic

Hypothermia as a Class **1** evidence for surviving STEMI (heart attack), plus cardiac arrest. Targeted Temperature Management is now recognized as a valid treatment for other Hyperthermia related illness like Malignant Hyperthermia, Heatstroke and Febrile Sepsis.

[0079] The missing link in the chain of survival for patients needing rapid cooling has been the lack of a noninvasive portable inexpensive device that can deliver cooling to the core circulation via the respiratory system. The disclosed noninvasive thermal material nebulizing system is for single patient use. The ergonomic, light weight easy use design can be used to deliver chilled mist to adults, children, infants, newborns and animals with beaks, trunks, or snouts for cooling via mask, mouth piece, pacifier mist delivery device (for infants), Aerosol Delivery Hood/Tent, Endotracheal tube, Blow-by and Bipap (noninvasive ventilation).

[0080] Various types of insulators have been tested including but not limited to Neoprene, Foil backed bubble wrap, plastic bubble wrap, Thermal evaporative material, foam.

Venues of Application and Use

[0081] Chilled mist via the disclosed thermal material nebulizing system can be used: [0082] In any venue with a supply of compressed oxygen, air or accessible portable nebulizer compressor to treat Epiglottis, Croup, RSV, Bronchospasm, Fever, Allergic Reaction, Smoke Inhalation, Blast Injury, Asthma, Bronchitis, Pneumonia, Laryngitis, Sepsis, COPD, ventilated patients, and pre and post ENT surgery. [0083] In any venue with a supply of compressed oxygen, air or accessible portable nebulizer compressor. [0084] To initiate core cooling during CPR. [0085] To initiate Therapeutic Hypothermia in any venue. [0086] As an adjunct during Targeted Temperature Management. [0087] By Paramedics/Flight Nurses/Military medics to initiate Therapeutic Hypothermia post Cardiac Arrest. [0088] In Emergency Departments, Intensive Care Units, Coronary Care Units, Critical Care Units and Operating Rooms to initiate or continue Therapeutic Hypothermia post Cardiac Arrest. [0089] By Paramedics, Military and Emergency Department medical personnel immediately upon recognition of myocardial infarction to initiate Therapeutic Hypothermia prior to re-vascularization in the Cardiac Catheterization Lab. [0090] By Pre-Hospital, EMS Paramedic/Firefighters/Flight Nurses/Military Medic, emergently treating Croup, RSV, Epiglottitis, Allergic Reactions, Bronchospasm, Laryngitis, Pneumonia, Asthma, COPD, Bronchitis, Heat Stroke and other heat related illness, heat/blast/smoke/exposure injury/inhalation, Sepsis and other airway compromising conditions. [0091] By Emergency Department Personnel emergently treating Croup, RSV, Epiglottitis, Allergic Reactions, Bronchospasm, Laryngitis, Pneumonia, Asthma, COPD, Bronchitis, Heat Stroke, heat/blast inhalation/exposure/injury, other heat related illnesses (chemically induced hyperthermia), Sepsis and other airway compromising conditions. [0092] In the Neurological ICU to initiate Therapeutic Hypothermia post Cerebral Vascular Accident and other Neurologic Hyperthermia related events. [0093] In the ENT postoperative setting to chill the mouth, nasopharynx and upper respiratory tract to decrease bleeding, swelling and to aid in pain control. [0094] To initiate tissue chilling by EMS, Emergency Department, Military medical and Wilderness Medical personnel for facial trauma to reduce nasopharyngeal and oral swelling and to aid in pain control. [0095] By Anesthesiology in the Operating rooms and ICU's to treat Anesthesia induced Hyperthermia by delivering chilled mist/medication/oxygen/air to the patients core via endotracheal tube, tracheotomy tube via Triple port nebulizer T-connector, mask, or mouth piece to initiate Therapeutic Hypothermia. [0096] By the patient at home for the treatment of Croup, Bronchitis, Asthma, COPD and other airway compromising illnesses. [0097] To connect to endotracheal (**32**) or tracheotomy tubes to initiate Therapeutic Hypothermia by delivering chilled mist/medication/oxygen/air to the patient's core. [0098] On airplanes, trains, and cruise ships. [0099] On space shuttle and space stations. [0100] By Pre-Hospital EMS Paramedics, Firefighters and/or Veterinarians emergently treating Animal airway compromise due to heat/smoke/inhalation/exposure or heat related illness via the Animal Rescue Mask. [0101] By Veterinarians in animal hospitals, clinics, zoos, and outpatient settings in treating asthma, allergic reaction and other airway compromising illnesses via the Animal Rescue mask.

[0102] The various embodiments described above can be combined to provide further embodiments. Aspects of the embodiments can be modified, if necessary to employ concepts of the various patents, applications and publications to provide yet further embodiments. For example, FIGS. **19** and **20** illustrate a double-walled configuration of a container **80** in which an inner wall **82** is integrally formed with an out wall **84**. This design creates an air space **86** between the two walls **82**, **84**. In accordance with one aspect of the present disclosure the air space **86** serves to insulate the interior of the container. Not only does this configuration maintain the cool temperature within the container **80**, it allows the user to hold the outer wall **84** for a prolonged period of time. Alternatively, the air space can contain the thermal material, either as an integrated part of the container as described above or as a refillable space through an opening in the outer wall **84**.
[0103] These and other changes can be made to the embodiments in light of the above-detailed description. In general, in the following claims, the terms used should not be construed to limit the claims to the specific embodiments disclosed in the specification and the claims, but should be construed to include all possible embodiments along with the full scope of equivalents to which such claims are entitled. Accordingly, the claims are not limited by the disclosure.

Claims

1. A portable nebulizing device for delivering a nebulized mist to the nostrils of an infant, the portable nebulizing device comprising: a portable container having a side wall, a bottom wall, an interior, an open top in communication with the interior, and an input port; a nebulizer sized and shaped to be located in the interior of the portable container, the nebulizer structured to generate the nebulized mist, the nebulizer including a housing having an opening, a top to cover the opening, a bottom, and an interior space, the housing having a fluid input in fluid communication with the interior space and coupleable to the input port of the portable container, and the top having a fluid output to be in fluid communication with the interior space to deliver the nebulized mist to the fluid output; a lid sized and shaped to cover the open top of the portable container and enclose the nebulizer in the interior of the portable container; a conduit to be coupled to the fluid output of the top of the nebulizer and to pass through the lid of the portable container, the conduit having a first end and a second end, the first end coupled to the fluid output of the nebulizer to provide fluid communication from the interior space of the nebulizer through the lid to deliver the nebulized mist from the fluid output to the second end of the conduit; and a pacifier mist delivery device coupled to the second end of the conduit to receive the nebulized mist from the nebulizer, the pacifier mist delivery device having a width and an air channel that spans the width of the pacifier mist delivery device and which is in fluid communication with the conduit, the pacifier mist delivery device further sized and structured to deliver nebulized mist to the nostrils of the infant.