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TractManager

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Ventilators: Strategic Sourcing during Coronavirus Pandemic

Executive Summary

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Ventilators: Strategic Sourcing during Coronavirus Pandemic

Situation

The complete clinical picture with regard to COVID-19 is not fully known. Reported illnesses have ranged from very mild, including some with no reported symptoms, to severe, including illness resulting in death.

Per the CDC:

> "While most people with COVID-19 develop mild or uncomplicated illness, approximately 14% develop severe disease requiring hospitalization and oxygen support and 5% require admission to an intensive care unit. In severe cases, COVID-19 can be complicated by acute respiratory disease syndrome (ARDS), sepsis and septic shock, multiorgan failure, including acute kidney injury and cardiac injury" (CDC, 2020).

Addressing altered pulmonary status and treating with the appropriate intervention is important. Interventions can range from oxygen via nasal cannula to extracorporeal membrane oxygenation (ECMO), with selection of an intervention based upon severity of illness and symptoms. Unfortunately, due to the overwhelming demand in some health systems, the selection of the most appropriate intervention may be altered by the availability of resources, particularly ventilators.

An evaluation has been requested of the current evidence and data available to safely source ventilators for the treatment of Covid-19 patients requiring respiratory support. This assessment includes vendors, models, features, and accessories for ventilators. This report will not address the use or evaluation of anesthesia machines or non-invasive ventilators, including continuous positive airway pressure machines and bilateral positive airway pressure machines.

When evaluating and sourcing ventilators, it will be important to understand the functionality for each model, in anticipation of the clinical requirements for recommended treatment as outlined in the guideline statements from the World Health Organization (WHO) and Surviving Sepsis COVID-19 subcommittee.

Background

Among patients who developed severe COVID-19 disease, the medium time to dyspnea ranged from 5 to 8 days, the median time to acute respiratory distress syndrome (ARDS) ranged from 8 to 12 days, and the median time to ICU admission ranged from 10 to 12 days.

Inpatient management revolves around the supportive management of the most common complications of severe COVID-19: pneumonia, hypoxemic respiratory failure/ARDS, sepsis and septic shock, cardiomyopathy and arrhythmia, acute kidney injury, and complications from prolonged hospitalization including secondary bacterial infections, thromboembolism, gastrointestinal bleeding, and critical illness polyneuropathy/myopathy (CDC, 2020).

Guidelines from the WHO and the Surviving Sepsis Campaign COVID-19 Subcommittee have been recently published and updated, and provide guidance on the management of critically ill adult patients with coronavirus disease, including specific recommendations for treatment of respiratory distress and progression to ARDS.

Technology Under Evaluation:
Ventilators for Covid-19 disease patients.

Goals:
1. Evidence-based requirements for ventilators that lead to patient safety during the Covid-19 pandemic.
2. Compliance with regulations and standard guidelines for invasive mechanical ventilation.
3. Operational considerations due to a shortage of ventilators.

Technology Description:
Invasive mechanical ventilation is provided via an endotracheal tube or tracheostomy. An endotracheal tube (ETT) is a plastic tube inserted through the nose or mouth to provide a secure airway. For COVID-19 patients requiring endotracheal intubation, The Surviving Sepsis Campaign COVID-19 subcommittee recommends that endotracheal intubation be performed by the healthcare worker who is the most experienced with airway management in order to minimize the number of attempts and risk of transmission, and suggest using video-guided laryngoscopy over direct laryngoscopy, if available, for endotracheal intubation (Alhazzani, et al., 2020).

A tracheostomy tube (breathing tube) is inserted through a surgically made opening through the front of the neck into the trachea to secure airway. The ventilator circuit refers to the tubing that connects the ventilator to the endotracheal tube or tracheostomy tube.

Ventilators

Requirements for a ventilator include basic ventilation modes and alarms. For sub-acute, PACU and long-term care, a basic configuration would be appropriate. For critical care, advanced ventilation modes and graphic monitoring are recommended. A noninvasive ventilation option may be considered for both sub-acute and critical care. This allows one machine to be used for intubated and non-intubated patients.

Ventilators offer a range of options to assist in various lung protective strategies. These options assist with lung recruitment by establishing optimal PEEP settings. Some ventilators offer

additional options such as CO_2 monitoring and Heliox delivery. If the machine will be used for transport within the hospital, the size of the machine, battery, and gas requirements should be considered. The type of nebulizer needed for medication delivery is also a purchase consideration. Current generation ventilators feature data output ports for EMR connection. Nurse call, remote alarm and printer ports are also available.

Technology Segments:
- **High-acuity systems** – These ventilators can be configured for all patient categories, including neonatal, pediatric and adult. These flexible systems offer the most advanced ventilation modes and monitoring. They are intended for use in the critical-care environment.
- **Medium-acuity systems** – These ventilators are designed for pediatric and adult patients. These systems offer multiple modes of ventilation and monitoring and are for use in critical care, emergency department, post anesthesia care and subacute care.
- **Low-acuity systems** – These ventilators are designed for pediatric and adult patients. They offer basic modes of invasive and noninvasive ventilation with minimal monitoring. They are intended for use in the emergency department, post anesthesia care, subacute care and long-term care.
- **Infant systems** – These are high-acuity systems specific to neonatal and infant applications. These ventilators are purchased for neonatal and pediatric critical care units and are not designed to support larger pediatric or adult patients.

Portable Ventilators

The equipment category for portable ventilators includes units designed for short-term transport of mechanically ventilated patients. This category also includes compact systems with advanced ventilation modes suitable for PACU, ED, sub-acute and long-term care environments. Portable ventilators are specifically designed to be compact and lightweight units. These ventilators are typically battery-powered, pneumatic or a combination of both. Pneumatic ventilators use a gas source for operation and for providing oxygen to the patient. Excessive gas consumption can be a concern with this type of ventilator. Battery-powered units depend on electrical power and gas supply. For use in transport, a strong, dependable battery is critical for this type of ventilator.

Requirements for a basic portable ventilator include variable rate, variable/volume ventilation mode, synchronized intermittent mandatory ventilation (SIMV), positive end expiratory pressure (PEEP), airway pressure monitor, and high pressure and low pressure/disconnection alarms. Both visual and auditory alarms are preferred. The unit should be fitted with a control panel cover or lock.

Technology Segments:
In the MD Buyline database, the portable ventilator market is divided into MR-conditional and non-MR-conditional segments.

- **MR-conditional** – ventilators that have been demonstrated to pose no known hazards in the MR environment with specified conditions of use.
- **Non-MR-conditional** – ventilators that are not designed for use in the MR environment.

Acuity type and application for Portable Ventilators:
- **Micro/ basic ventilator** – small size, basic features. (Ex. Airon Corporation, Smiths Medical).
- **Micro ventilator** – additional features, modes of ventilation, and FiO2 options. (Ex. ZOLL, Bio-Med Devices)
- **Subacute/ Homecare** – fall under low acuity ventilator or portable category. Full function with compact size. (Ex. Vyaire, Philips and Medtronic)
- **High acuity portable ventilator** – (Hamilton-T1)
- **Specialty** – Homecare unit with unique features. (Ventec Life Systems VOCSN) GM and Ventec deal to product VOCSN ventilators has been placed on hold.

Guidelines

Evidence-based treatment guidelines for ARDS should be followed, including conservative fluid strategies for patients without shock following initial resuscitation, empirical early antibiotics for suspected bacterial co-infection until a specific diagnosis is made, lung-protective ventilation, prone positioning, and consideration of extracorporeal membrane oxygenation for refractory hypoxemia.

The FDA recently released an approved list for Authorized Ventilators, Ventilator Tubing Connectors, and Ventilator Accessories:

https://www.fda.gov/media/136528/download

The CDC and FDA guidelines for Covid-19 ventilator usage and procedures are evolving to adapt to the changing needs of patients and providers. The FDA issued the following guidance in March: ***"Enforcement Policy for Ventilators and Accessories and Other Respiratory Devices During the Coronavirus Disease 2019 (COVID-19) Public Health Emergency"***
https://www.fda.gov/media/136318/download

> This guidance outlines a policy intended to help increase the availability of ventilators and their accessories as well as other respiratory devices during the COVID-19 pandemic. Specifically, the policy fosters the continued availability of certain safe and effective medical devices while being flexible regarding manufacturer modifications made to ventilators, anesthesia gas machines and other respiratory devices, and their accessories, in response to the COVID-19 public health emergency.
> In choosing the best ventilation option for your patient, you should consider your patient's condition, the available technology, and the respiratory care expertise and experience present in your institution.

The FDA's recommendations are intended to augment, not replace, specific controls and procedures developed by health care organizations and the Centers for Disease Control and Prevention (CDC). https://www.fda.gov/regulatory-information/search-fda-guidance-documents/enforcement-policy-ventilators-and-accessories-and-other-respiratory-devices-during-coronavirus

The Surviving Sepsis Campaign COVID-19 Panel issued several recommendations in their guidelines to help support healthcare workers caring for critically ill ICU patients with COVID-19, with further releases expected as evidence evolves (Alhazzani, 2020).   This document details specific ventilator settings recommended for treating COVID-19 patients at different levels of severity.

The WHO has issued the second edition of guidelines: Clinical Management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected (March, 2020). It is intended to provide interim guidance to clinicians treating confirmed or suspected COVID-19 patients with mild, moderate, and critical illness, including acute respiratory distress syndrome (ARDS).

Operational Considerations

Due to the Covid-19 pandemic, ventilators are in high demand and hospitals are looking to mitigate shortages within their facilities. Recommendations to use FDA-cleared conventional/standard full-featured ventilators **when available** to support patients with respiratory failure. To prepare for a potential shortage of ventilators, the FDA issued recommendations intended to help increase availability of ventilators and their accessories during the Covid-19 pandemic listed below:

- The CDC and FDA guidelines for Covid-19 ventilator usage and procedures are evolving to adapt to the changing needs of patients and providers. The FDA has issued **The Enforcement Policy for Ventilators and Accessories and Other Respiratory Devices during the Coronavirus Disease 2019 (COVID-19) Public Health Emergency** to provide a policy to help expand the availability of ventilators as well as other respiratory devices and their accessories during this pandemic: https://www.fda.gov/media/136318/download

Strategic National Stockpile (SNS) maintained by the CDC is a repository of medical supplies and equipment including mechanical ventilators. The designated equipment is available to supplement acute care hospitals throughout the country in the event of a large-scale public health emergency. *The current models available are Medtronic (Covidien)LP10, Vyaire (Carefusion) LTV1200, and ZOLL (Impact Instrumentation) Uni-vent Eagle 754 ventilators.*

On-line training is also available through the AARC (American Association of Respiratory Care) website http://www.aarc.org/resources/sns_vent_training/. Training includes AARC webcasts, manufacturer operator videos and electronic manuals, and mass casualty cross-training videos.

In March 2020, President Trump signed the Defense Production Act which allows the government to marshal the private sector to ramp up production of certain supplies. The Department of Health and Human Services announced a vendor contract under the Defense Production Act to produce 30,000 ventilators that will be delivered to the SNS to assist with the ventilator shortage (SNS, 2020).

It is important to understand federal, state, and local efforts that may be in existence for sourcing of equipment and supplies, particularly ventilators, ancillary disposables, and trained personnel to provide education and/or oversight when new and/or unfamiliar technology is utilized in practice.

The applicability of the information presented may be varied secondary to the mode of operation within a healthcare facility; specifically, conventional operation versus contingency operation, versus crisis mode operation. The acquisition of ventilators, ancillary supplies, and personal protection equipment, including sourcing and negotiation, as well as the application of evidence-based recommendations, may vary for each of these operating modes.

Financial Considerations:
The following tables list ventilator and portable ventilator technical specifications by market segment, with benchmark pricing. Monitoring supply behavior is suggested and encouraged, particularly in regard to future business relationships.

Sourcing Tables

Table 1. Ventilators: High Acuity

Technology: Ventilator
Market Segment: High Acuity

	Drager	GE	Getinge	Getinge	Getinge	Hamilton Medical	Hamilton Medical	Hamilton Medical	Medtronic	Medtronic	Vyaire	Vyaire
OEM												
Product	Evita Infinity V500	Carescape R860	Servo-i Adult Platform	Servo-i Universal Platform	Servo-U	HAMILTON-C1	HAMILTON-C3	HAMILTON-G5	840	PB980	AVEA Comprehensive	AVEA Standard
Avg Quoted Price	$31,698	$34,023	$24,338	$37,172	$40,898	$19,740	$24,662	$37,156	$24,759	$37,390	$30,480	$28,962
Tech Specs												
Clinical Applications	High Acuity	High Acuity	High Acuity	HighAcuity	High Acuity	High Acuity	HighAcuity	High Acuity	High Acuity	High Acuity	High acuity	High acuity
Ventilation Modes	VC-CMV, VC-SIMV, VC-AC, VC-MMV, PC-CMV, PC-SIMV, PC-AC, PC-PSV, SPN-CPAP/PS, SPN-CPAP/VS	A/C VC, A/C PC, A/C PRVC, SIMV-VC, SIMV-PC, CPAP/PS, PEEP/e, PEEP/n, APRV, VS, NIV (pedialult), NCPAP (Neonatal Mode).	Volume Control, Pressure Control, Pressure Support, SIMV, CPAP	Volume Control, Pressure Control, Pressure Support, SIMV, CPAP	Volume Control, Pressure Control, Pressure Support, SIMV, CPAP	PCV+, PSIMV+, SPONT, APRV, DuoPAP, (S)CMV+APV(cmv, SIMV+APV)simv, NIV, NIV-ST, optional neonatal nCPAP/PS	PCV+, PSIMV+, SPONT, APRV, DuoPAP, (S)CMV+APV(cmv, SIMV+APV)simv, NIV, NIV-ST, Optional neonatal nCPAP/PS	Volume Control, Assist Control, Pressure Control, Pressure Support, SIMV, CPAP, NIV, Spontaneous, APRV, Volume control (S)CMV, SIMV, Pressure Control P-CMV P-SIMV; Spontaneous (Pressure Support) Volume Targeting: APV cmv, APV simv, Volume Support; Closed Loop Volume Targeting; Adaptive Support Ventilation (ASV); APRV, DuoPAP, Noninvasive Ventilation; NIV, NIV S-T; Smart Apnea back-up. Optional neonatal nCPAP/PS	Volume Control, Assist Control, Pressure Control, Pressure Support, SIMV, NIV, Spontaneous, APRV, Volume Support	Volume Control, Assist Control, Pressure Control, Pressure Support, SIMV, NIV, Spontaneous, APRV, Volume Support	Volume Control Pressure Control Pressure Support SIMV CPAP PRVC Spontaneous us Apnea back-up	Volume Control, Assist Control, Pressure Control, Pressure Support, SIMV, CPAP, NIV, Spontaneous, Apnea Back-up, Neonatal CPAP
Display	Peak Inspiratory Pressure, Plateau Pressure, PEEP, MAP, Pinsp, Pmgh, EIP, PEEPi, P.01, MV, Ti, Tve, %leak, RR, I:E, R, Mleak, ETCO2, VCO2, ccKg	At set pressure based on mode. Airway pressure, Patient Flow, respiratory rate, VT, MV, CO2, compliance, resistance, VCO2, FiO2, RSBI index.	PEEP, MV, Inspired/Expired VT, Graphical user interface includes standard values, alarms, O2%, rate.	PEEP, MV, Inspired/Expired VT, Graphical user interface includes standard values, alarms, O2%, rate.	PEEP, MV, Inspired/Expired VT, Graphical user interface includes standard values, alarms, O2%, rate.	Touchscreen, Intelligent Ventilation Cockpit, including Dynamic Lung Panel, Vent Status Panel	Touchscreen, Intelligent Ventilation Cockpit, including Dynamic Lung Panel, Vent Status Panel, over 44 monitored parameters	Touch Screen Intelligent Ventilation Cockpit, including Dynamic Lung Panel, Vent Status panel, over 44 monitored parameters	Dual View touch screen display monitored data separately from ventilator settings. The Sandbox Screen allows set up and review of settings before application. Additional screen on breath delivery unit (BDU) with data display, available separate from GUI	Touch screen display has swipe and double tap control features. The Sandbox Screen allows set up and review of settings before application, displays data separately from ventilator settings.	Choice of 36 parameters, trending of all parameters	Choice of 36 parameters, trending of all parameters
Alarms	Minute Volume, Paw, FiO2, CO2, RR, Tidal Volume, Apnea Time	VT low/ high/ high; MV low/high; RR low/ high; FiO2 low/high; Pmax, Ppeak, PEEP-e, PEEP, Pinint, Apnea, circuit leak, EtCO2.	Gas Supply Failure, Low Battery, Airway pressure, minute ventilation RR, apnea, technical	Gas Supply Failure, Low Battery, Airway pressure, minute ventilation RR, apnea, technical	Gas Supply Failure, Low Battery, Airway pressure, minute ventilation RR, apnea, technical	Low/high MV; high pressure; low/high Vt; low/high rate; apnea time; low/high longer; concentration; disconnect; loss of PEEP; high PEEP; exh obstruction; low oxygen; ASV power supply; batteries; gas supply	Low/high MV; high pressure; low/high Vt; low/high rate; apnea time; low/high longer; oxygen concentration; disconnect; loss of PEEP; high PEEP; exhalation obstruction; low sensor; ASV power supply; batteries; gas supply	Gas Supply Failure, Power Failure, Ventilator inoperative; High/low MV; high/low pressure; high/low Vt; high/low rate; apnea loss of PEEP; High PEEP; exhalation obstructed; patient effort disconnect; pressure limit; settings conflict.	Smart Alert alarms include: high circuit press., high exhaled MV, Vt; low exhaled MV, Vt; high rate; volume not delivered, disconnect; occlusion.	Smart Alert alarms high circuit pressure, high exhaled MV, Vt; low exhaled MV, Vt; high rate; volume not delivered, disconnect; occlusion, fan failure	Low/high peak pressure; low PEEP; low/high minute ventilation; low/high Vt; high RR; Apnea; low/high FiO2; circuit disconnect; low battery; I:E Limit; I-Time Limit; Loss of AC power; fan failure	Low/high peak pressure; low PEEP; low/high minute ventilation; low/high Vt; high RR; Apnea; low/high FiO2; circuit disconnect; low battery; I:E Limit; I-Time Limit; Loss of AC power; fan failure
Options	SmartCare/PS, Low Flow/PV Loop, NIV, CO2, Neoflow	SIMV, PRVC, BiLevel, APRV, VS, NIV, nCPAP, SpnO Dynamics, PRO (Neleve Metabolic Module, CO2 Module.	Compressor; Software options; sensor	Compressor; Software options; Y-sensor	Compressor; Software options; remote alarm; Y-sensor	Cylinder holder; mainstream volumetric capnography; sidestream capnography neonatal software; nCPAP-PC, loops, trending.	Cylinder holder; mainstream volumetric capnography; sidestream capnography neonatal nCPAP-PC, loops, trending	Wide trolley, Ventilair II compressor; cylinder holder; integrated power strip; extended batteries; Heliox; P:V Tool Pro; volumetric mainstream or sidestream capnography; neonatal nCPAP-PS; Aerogen Masimo Oximetry, Medisoft; high flow O2 therapy.	Compressor; Humidifier	Compressor; Humidifier	Volumetric CO2; external battery; tank holder	Pt's maneuver, nasal CPAP IMV, Volume Guarantee, Volumetric CO2, Heliox delivery system, internal compressor, deluxe cart, external battery, tank holder
Patient Population	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult	Neonatal; Pediatric; Adult
Nebulizer	Integrated/Pneumatic	Works w/disposable Aeroneb nebulizers.	Optional Aeroneb nebulizer	Optional Aeroneb nebulizer	Optional Aeroneb nebulizer	Internal	Internal/optional Aerogen nebulizer.	Volume compressed; Insp/Exp/Continuous modes; adjustable shut-off; Optional Aerogen nebulizer.	Aerogen/ AeroNeb	Aerogen AeroNeb	Synchronized	Synchronized
Unique Features / Capabilities	Autoflow; Volume Guarantee; Variable P.S.; Smart Pulmonary View; 02 Therapy; Sighs, ATC; Suction Support	FRC (Neleve SpiroDynamics. Gas Monitoring, EtCO2; optional Metabolics and Energy Expenditure, Spirometry via ventilator or Compact Airway Module; Airway Resistance Compensation, VCO2, VCO2, Leak Compensation, Trigger Compensation.	Vent record card; transportability; flexible upgrades; MR-Conditional option; NAVA option; Heliox option; Universal Platform is available in the Basic and Extended Editions; Universal Extended includes Automode, open lung tool, PRVC, VS, SMV-PRVC	Vent record card; transportability; flexible upgrades; MR-Conditional option; NAVA option; Heliox option; Universal Platform is available in the Basic and Extended Editions; Universal Extended includes Automode, open lung tool, PRVC, VS, SMV-PRVC	Vent record card, transportability; flexible upgrades, NAVA option; automatic calculation of WOB W; SAFETY SCALE decision support tool; SERV-O-n platform is available for neonatal applications only.	HAMILTON-C1 is also available as the HAMILTON-C1 neo dedicated neonatal/infant ventilator; Adaptive Support Ventilation mode; Tube powered; exit battery w/ swappable batteries; IntelliTrig leak compensation; synchronization, ventilation status panel; breath-by-breath lung mechanics, object-oriented GUI-picture from patient data; high- or low-pressure oxygen operation.	Adaptive Support Ventilation mode; Adaptive controller: Vt-lowest press, proc. p/t monitoring, IntelliTrig, leak compensation with WOB W Tool Pro; vent. status panel; breath-by-breath lung mechanics; object-oriented GUI-picture from patient data; high- or low-pressure oxygen operation.	Volume compressed; Insp/Exp/Continuous modes; adjustable shut-off Optional Aerogen nebulizer.	Upgradeable software platform; 840 is available in three platforms: Neonatal, pediatric-adult, and universal	Upgradeable software platform; the 980 is available in three platforms: Neonatal, pediatric-adult, and universal	Transpulmonary Pressure tracheal pressure monitoring, proximal airway pressure monitoring, variable orifice flow sensor, hot wire flow sensor (neo), synchronized independent lung ventilation, internal compressor, integrated heliox, Knowledge Portal	Proximal hot wire flow sensor (neonatal), 24-hour trending of 35 parameters plus events, synchronized independent lung ventilation, volume limit, Knowledge Portal
Power Requirements	100-240 V / 50/60 Hz	AC: Standard, 115v/DC; 30 minute minimum battery backup; up to 85 minutes when fully charged Gas Supply/Operating Pressure 35-94 psi	AC: Standard, 100-120v/DC: Approximately 3 hours w/6 batteries; Gas supply operating pressure; 29-94 PSI	AC: Standard, 100-120v/DC: Approximately 3 hours w/6 batteries; Gas supply operating pressure; 29-94 PSI	AC: Standard, 100-120v/DC: Approximately 3 hours w/6 batteries; Gas supply operating pressure; 29-94 PSI	AC: Standard, 115v/DC; 2 hours swappable batteries, approximately 4 hours, Gas supply operating pressure; 29-68 PSI	AC: Standard, 115v/DC; 2 hours swappable batteries, approximately 3.8 hours each; Gas Supply operating pressure; 29-68 PSI (HPO)	AC: Standard, 115v/DC: Integrated battery for approximately 1 hour operating pressure; 29-86 PSI	AC: Standard, 115v/DC: 1 hour standard; Unlimited with optional hot-swappable battery; Gas supply operating pressure; 35-100 PSI	AC: Standard, 115v/DC: 1 hour standard; Unlimited with optional hot-swappable battery; Gas supply operating pressure; 35-100 PSI	AC: 100,120, 230, 240 VAC, 47 to 65 HZ/DC: 1-hr internal battery on ventilator alone, 30 minutes ventilator and compressor (standard); 4-hour external battery ventilator; 2-hour ventilator and compressor (optional); Gas supply oxygen/air 20-80 PSIG	AC: 100, 120, 230, 240 VAC, 47 to 65 HZ/DC: 1-hr internal battery on ventilator alone, 30 minutes ventilator and compressor (standard); 4-hour external battery ventilator; 2-hour ventilator and compressor (optional); Gas supply oxygen/air 20-80 PSIG
Advanced Ventilation Modes	PC-APRV, SPN-PPS	Neonatal, APRV, BiLevel, BiLevel V.G, SMV, PRVC, nCPAP	Optional: PCV, NIV, BiVent, Automode, open lung tool, NAVA, PRVC, VS, SMV-PRVC, CO2, NCPAP	Optional: NIV, BiVent, Automode, open lung tool, NAVA, PRVC, VS, SMV-PRVC, CO2, NCPAP	Neonatal; Optional NIV, BiVent, Automode, open lung tool, NAVA, PRVC, VS, SMV-PRVC, CO2, NCPAP	ASV adaptive support closed-loop ventilation; APRV	ASV adaptive support closed-loop ventilation; APRV / TRC-tube resistance compensation	ASV - adaptive support closed ventilation; APRV / DuoPAP TRC- tube resistance compensation	ASV - adaptive support closed loop ventilation; APRV, DuoPAP; TRC- tube resistance compensation	BiLevel, Tube Compensation, Neonatal, Proportional Assist Ventilation + Volume Ventilation+, advanced modes optional	Airway Pressure Release Ventilation/BiPhasic (APRV/BiPhasic), PRVC, nasal CPAP/IMV, Volume Guarantee, Time Cycled Pressure Limited (TCPL), Machine Volume	Airway Pressure Release Ventilation/BiPhasic (APRV/BiPhasic), PRVC, Time Cycled Pressure Limited (TCPL), Machine Volume
Graphics	Waveforms, Loops, Trends, Pulmonary View, Customized table, Freeze Screen, Screen Shot, Pulmonary View, Day/Night Function	Waveforms up to four at a time. Graphics Scaling. Parameters: pressure, volume, CO2, O2 and other pressure-volume, pressure-volume, pressure-flow, flow-volume; Pressure bar graph Trends/master timeline; Spirometry/spirodynamic loops	Waveforms; pressure, flow, volume; Loops: pressure/volume and flow/volume; Metrics: CO2 opt. Respiratory mechanics; real time and trended	Waveforms; pressure, flow, volume; Loops: pressure/volume and flow/volume; Metrics: CO2 opt. Respiratory mechanics; real time and trended	Waveforms; pressure, flow, volume; Loops: pressure/volume and flow/volume; Metrics: CO2 opt. Respiratory mechanics; real time and trended	Real-time curves vol, flow, pressure, press. Loops: pressure/vol, vol/flow, capnogram; Trends 1, 12, 24 and 72 hr; Freeze screen; event log; Advanced graphical user interface (GUI)- dynamic lung, vent status, ASV intelligent display	Real-time curves vol, flow, pressure, cross, Loops: pressure/vol, vol/flow, capnogram; Trends 1, 12, 24 and 72 hr; Freeze screen event log; Advanced graphical user interface (GUI)- dynamic lung, vent status, ASV intelligent display	Real-time curves vol, flow, pressure, esophageal press; Loops: press/vol, vol/flow; Trends 1, 12, 24 and 72 hr; Freeze screen event log; Advanced GUI- dynamic lung, vent status, ASV intelligent display	BiLevel, Tube Compensation, Neonatal, Proportional Assist Ventilation + Volume Ventilation+, advanced modes optional	Curves; Pressure-Time, Flow-Time, Volume-Time; Loops: Pressure-Volume	Selectable, full color waveforms. Displays 5 values with waveforms/loops or trends. Displays up to 15 monitored values without waveforms. Pt's maneuver	Selectable, full color waveforms. Displays 5 values with waveforms/loops or trends. Displays up to 15 monitored values without waveforms. Pt's maneuver
Interfacing	3 RS-232 adapters, 4 USB ports back panel, 2 USB ports side panel, 1 DVI port, 2 RJ-45 ethernet port	Output Ports, Remote Alarm/ Display, Serial port RS-232, RS-485 port, RS-422 port 2 USB ports, Ethernet port, Connectivity to majority of patient monitoring/ GSI/ HIS systems	Output Ports, Optional remote alarm	Output Ports, Optional remote alarm/display	Output Ports, Optional remote alarm/display	Output Ports, Remote Alarm/ Display, Communication interface	Output Ports, Remote Alarm/ Display, Communication interface	Output Ports/Remote Alarm/ Display/Communications interface including 2 RS-232C port, remote nurse call, I:E signal; USB	Remote Alarm/ Display, Standard RS-232, Connectivity to most patient monitoring/ GSI/ HIS systems	Remote Alarm/ Display, Standard RS-232, Connectivity to most patient monitoring/ GSI/ HIS systems	One RS-232 comm outlet port, One RS-232 software upgrade port, SVGA output, analog input/output and parallel printer port; Coordination Engine (CCE)	One RS-232 comm outlet port, One RS-232 software upgrade port, SVGA output, analog input/output and parallel printer port; Coordination Engine (CCE)
Warranty	One year	1 years	One year	One year	One year	One year labor; two-year parts warranty standard; Service Cost per year w/BME support $393.84 for P/M kit, FiO2 cell, one internal battery every 3 years.	One year labor; two-year parts warranty standard; Service Cost per year w/BME support $393.84 for P/M kit, FiO2 cell, one internal battery every 3 years.	One year labor; two-year parts warranty standard; HAMILTON-G5 w/Galvanic FiO2 cell; Service Cost per year w/BME support $352.74 for P/M kit, FiO2 cell, one internal battery every 2 years. HAMILTON-G5 w/paramagnetic FiO2 cell: Service Cost per year w/BME support $193.46 for P/M kit, one internal battery every 2 years.	Three year standard	One year	Two years	Two years

Table 2. Ventilators: Medium Acuity

Technology: Ventilator
Market Segment: Medium Acuity System

OEM	Draeger	Getinge	Vyaire
Product	Savina 300	SERVO-s	VELA Comprehensive
Avg Quoted Price	$17,851	$34,829	$16,395
Tech Specs			
Clinical Applications	Low to Mid Acuity - Savina 300 Classic or Select Model	Mid Acuity	Mid acuity, NIV, transport
Ventilation Modes	Pressure Control, SIMV, CPAP, NIVVC-SIMV, VC-CMV/ VC-AC, PC-SIMV+, SPN-CPAP/PS	Volume Control, Pressure Control, Pressure Support (PS)/CPAP; SIMV-VC	Volume Control, Assist Control, Pressure Control, Pressure Support, SIMV, CPAP, Spontaneous, NPPV, CPAP/ PSV, NPPV SIMV, NPPV A/C, Apnea Back-up
Display	12"color screen; real-time waveforms, measured parameters, settings, P peak, P plat, P mean, PEEP, P min, MV, MV spont, MV leak, Vt insp, Vt exp., I:E ratio, resistance, compliance, FiO2%, Temp.	Graphical user interface includes standard values, alarms, O2%, rate	Scalable graphic displays for Paw (cmH20), V (lpm), Vt (ml); 5 parameters selectable from 16 options viewed on main screen; trending of all parameters
Alarms	MV high, MV low, Paw high, VT high, RR high, Apnea time; additional: %O2, disconnect, PEEP low, Press limit, spontaneous breath, flow sensor, temp.sensor, O2 sensor, gas supply, battery, technical, inoperative	Airway pressure, minute ventilation, RR, apnea, gas supply, battery, technical	Low battery, Safety valve open, low/high pressure, low minute volume, high RR, apnea interval, high PEEP, no flow sensor, loss O2, low/high O2
Options	300 Classic: CO2 w/sensor, Monitoring, Plus, Special Manuevers, Autoflow, NIV (mask), Nurse Call, Low Pressure Oxygen (LPO), external battery, cart/trolley, nebulizer, humidifer. 300 Select also offers: PC-APRV, VC-MMV, ATC.	PRVC; SIMV-PRVC; BiVent; NIV; remote alarm; mini-compressor	3 VELA models available: Standard, Plus and Comprehensive; Mode upgrades available
Patient Population	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult
Nebulizer	Built-in (pneumatic)	Optional Aeroneb nebulizer	Synchronized, selectable: 1 to 60 minutes
Unique Features/ Capabilities	Turbine-driven ventilator with standard internal battery"Open-Breathing-System" to support spontaneous breathingMask ventilation (NIV) in all ventilation modes availableSavina 300 Select model includes PediatricPlus, Special Manuevers, Monitoring Plus, quick Start-Up; User Logbook	Selectable between touch screen, direct access knobs or dialShelf mounting option	Turbine technology powers system and provides independence from wall air source for mobility; Internal battery: six hours standard; Low or high pressure O2 inlet; Integrated end tidal capnography monitoring; Knowledge Portal
Power Requirements	AC: (Standard)100-240VInternal battery for approx. 60 minutes (Standard)DC: (Optional) 10-30V DC external battery 4-6 hoursGas Supply Operating Pressure: O2: 40-87 psi; Air: Internal turbine	AC: Standard, 100-120VDC: Approximately 1 hour; recharge time 6 hoursGas supply operating pressure: 29-94 PSI	AC: standard, 100, 120, 230, 240 VAC, 47 to 65 HzDC: six hour internal batteryGas supply: O2 40-85 PSIGTurbine technology does not require compressed air source.
Advanced Ventilation Modes	Optional: AutoFlow, PC-SIMV+, NIV, PC-APRV, VC-MMV	Apnea back-up in support modes; optional PRVC; optional NIV; optional BiVent	Airway Pressure Release Ventilation/ BiPhasic (APRV/BiPhasic); PRVC; Assured Volume
Graphics	Real-time waveforms: pressure/time, flow/time	Pressure, flow, volume waveforms	Selectable, full color waveforms: pressure, flow, volumeLoops: pressure/volume; flow/volumeDisplays up to 15 monitored values without waveforms
Interfacing	1 RS-232 port & Nurse Call	Output Ports	Remote Alarm/ DisplayRS232, SVGA output, printer capabilities; Generic Serial Protocol and VOXP communication protocols standard; Coordination Engine (CCE)
Warranty	One year	One year	Ventilator: Two years (excludes PMs)Turbine: Five years or 40,000 hours

Table 3. Ventilators: Infant

Technology: Ventilator
Market Segment: Infant System

OEM	Draeger	Getinge
Product	Babylog VN500	Servo-n
Avg Quoted Price	$25,843	$40,011
Tech Specs		
Clinical Applications	High Acuity	High Acuity
Ventilation Modes	PC-CMV, PC-AC, PC-SIMV, PC-PSV, PC-MMV (optional)	Volume Control, Pressure Control, Pressure Support, SIMV, CPAP
Display	Peak Inspiratory Pressure, Plateau Pressure, PEEP, MAP, Plow/Phigh, EIP, Tvi, Tve, %leak, Ti(sport), I:E, RR, Cdyn, R, C20/C, CO2, cc/kg	PEEPMV, Inspired/Expired VT, Graphical user interface includes standard values, alarms, O2%, rate.
Alarms	Minute Ventilation, Paw, FiO2, CO2, RR, Tidal Volume, Apnea, Disconnect	Gas Supply Failure, Low Battery, Airway pressure, minute ventilation, RR, apnea, technical
Options	ATC, VG, NIV, Compressor, Tank Rack	Compressor, Software options; remote alarm; Y-sensor
Patient Population	Neonatal, Infant	Neonatal
Nebulizer	Integrated/ Pneumatic	Optional Aeroneb nebulizer
Unique Features/ Capabilities	Leakage Compensation, Suction Manuever, Insp Hold, Sighs, Apnea Ventilation with AutoReturn, O2 therapy, Pneumatic Nebulizer	Vent record card; transportability; flexible upgrades; NAVA option; automatic calculation of Vt/PBW; SAFETY SCALE decision support tool. SERVO-n platform is available for neonatal applications only.
Power Requirements	100-240v / 50/60 Hz	AC: Standard, 100-120VDC: Approximately 3 hours with 6 batteries; Gas supply operating pressure: 29-87 PSI
Advanced Ventilation Modes	PC-APRV (optional), SPN-CPAP/PS, SPN-PPS (optional), SPN-CPAP/VS (optional)	Neonatal; Optional: NIV, BiVent, Automode, open lung tool, NAVA, PRVC, VS, SIMV-PRVC, CO2, NCPAP
Graphics	Waveforms, Loops, Trends, Pulmonary View, Customized Table, Freeze Screen, Screen Shot, Pulmonary View, Day/Night Function	Waveforms: pressure, flow, volume; Loops: pressure/volume and flow/volume; Metrics: CO2opt; Respiratory mechanics: real time and trended
Interfacing	3 RS-232 Adapters, 4 USB Ports Back Panel, 2 USB Ports Side Panel, 1 DVI Port, 2 RJ 45 Eth	Output Ports, Optional remote alarm/display
Warranty	One Year	One year

Table 4. Portable Ventilators: MRI Conditional

Technology: Portable Ventilator
Market Segment: MRI Conditional

OEM	Airon	Bio-Med	Bio-Med	Hamilton Medical	Smiths Medical	Smiths Medical	Smiths Medical	ZOLL Medical
Product	pNeuton	IC-2A MRI	MVP-10 MRI	HAMILTON-MR1	babyPAC	paraPAC	paraPAC, plus	Z Vent
Avg Quoted Price	$8,400	$8,604	$6,353	$36,575	$10,690	$7,038	$5,992	$13,769
Tech Specs								
Ventilation Modes	Invasive or noninvasive: CMV, IMV, CPAP, Pressure Limit	SIMV, CPAP, Continuous Mandatory Ventilation; Manual; Pressure Ventilation; Built-in PEEP	CPAP, Control Mode Ventilation (CMV), PEEP, IMV	ASV, (S)CMV+/APVcmv, SIMV+/APVsimv, PCV+, SPONT, PSIMV+, APRV	Pressure Control, IMV/CPAP, CPAP	SIMV (Synchronized Minimum Mandatory Ventilation)/demand	SIMV (Synchronized Minimum Mandatory Ventilation)/demand; CPAP, Oxygen Therapy, Manual	Assist Control, SIMV, SIMV w/ Pressure Support, CPAP, CPAP w/Pressure Support, Noninvasive Bilevel, Inverse Ratio
Clinical Applications	Flight medicine, Inter-hospital, Intra-hospital, MRI, Emergency Department	Flight medicine, Inter-hospital, Intra-hospital, MRI, Emergency Department	Flight medicine, Inter-hospital, Intra-hospital MRI	Inter-hospital, MRI, Emergency Department	Inter-hospital, Intra-hospital, MRI, Emergency Department	Inter-hospital, Intra-hospital, MRI, Emergency Department	Inter-hospital, Intra-hospital, MRI, Emergency Department	Intrahospital, pre-/post-op, ED, ICU
Monitor/Display	Inspiratory Pressure	Max. Pressure	Max. Pressure/Flow Rate	Touchscreen, Intelligent Ventilation Cockpit, Dynamic Lung Panel, Vent Status Panel, 30 monitoring parameters	Inflation Pressure Monitor	Inflation Pressure Monitor	Inflation Pressure Monitor	Heart rate, O2 Sat: FiO2; PIP; PEEP; PS, Tidal Volume; Ventilation rate; I:E settings; Insp. time; Pleth; Press/Time waveform; Plateau Pressure; Tubing Compensation; leak compensation; SmartHelp™ alarm mitigation
Alarms	Patient circuit disconnection; low oxygen inlet pressure; remote alarm output	M-1 pressure monitor; M-10 pressures, PEEP, rate, I:E, temp., FIO2	M-1 pressure monitor; M-10 pressures, PEEP, rate, I:E, temp., FIO2	TeslaSpy guassmeter, low/high MV, high pressure, low/high tidal volume, low/high rate, apnea time, low/high oxygen, oxygen concentration, disconnect, loss of PEEP, exhalation obstruction, flow sensor, ASV power supply, low battery, gas supply failed	Optional Integrated Electronic Pressure Monitoring/Alarm System (low pressure/disconnect, low battery, high pressure, single gas failure + visual indicators)	Optional Integrated Electronic Pressure Monitoring/Alarm System (low pressure/disconnect, low battery, high pressure, spontaneous breathing + visual indicators)	Audible electronic & pneumatic high/low pressure alarm; visual high/low pressure indicator; disconnect audio/visual alarm; indicator lights for low battery, spontaneous, silence and normal breath	Lo/Med/High priority; Low Battery; High Pressure; Low Pressure; Alarm Mute/Cancel; Apnea; Low Pressure Disconnect; PEEP leak
Dimensions	5"H x 10"W x 7"D	Height: 10-1/4" Width: 6" Depth: 3-3/8"	Height: 8" Width: 9" Depth: 3"	12" x 9" x 8"	3.7"H x 8.7"W x 6.4"D	3.7"H x 8.7"W x 6.4"D	3.7"H x 9.25"W x 6.5"D	Height: 12.5" Width: 7.5" Depth: 4.5"
Weight	6.50 lbs	9 lbs	5 lbs	15 lbs	8.30 lbs	6.60 lbs	5.30 lbs	9.70 lbs
Power Requirements	Pneumatic operation	Power: 50+5 PSI Gas Source	Power Supply: 50+5 PSI Gas Source	AC: Standard, 115vDC: (2) sealed batteries	Pneumatically powered: 50 PSI gas source	Pneumatically powered: 50 PSI gas source	Pneumatically powered: Medical Oxygen 280-600kPa	External AC/DC: 11.25-30.8 VDC Continuous Internal Battery (10 hours backup): Lithium ion Internal 12-valve rotary compressor
Options	Mobile stand; manifold system; bed rail mount; travel bag; oxygen regulator; high-pressure hose	Blender, Roll Stand	MRI option, Blender, Roll Stand	APRV, DuoPAP, NIV, NIV-ST, nCPAP-PC, loops, trending	PEEP 0-20cmH2O	PEEP 0-20cm H2O, Integrated Electronic Pressure Monitoring/Alarm system (low pressure/disconnect, low battery, high pressure, spontaneous breathing + visual indicators)	Internal PEEP CPAP. Free flow oxygen delivery, PEEP 0-20cm H2O/CPAP 0 to a max of 16cm H2O at 35l/min flow (depending upon patient condition)	Pole mount, wall mounting plate, roll stand, specialty mounts for stretchers and beds
Patient Population	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult	Pediatric, Adult
Battery Backup	No batteries or external power required	Not required	Not required	Up to 9+ hours	Electrical connections/battery required for alarms only	Electrical connections/battery required for alarms only	Electrical connections/battery required for alarms only	10 hours
Gas Requirements	Oxygen, 55 psi +/- 15 psi	50 PSI gas source	50 PSI gas source	Gas supply operating pressure: 29-68 PSI	50 PSI gas source	50 PSI gas source	50 PSI gas source	55 PSIG of O2
Other Features	Demand flow CPAP system; oxygen settings 100% or 65%; MRI conditional up to 3 T	Gas powered/non-electric	Range of I/E ratio settings, including inverse; Gas powered/non-electric	Adaptive Support Ventilation; turbine-powered; ventilation status panel; TeslaSpy gaussmeter. Service Cost per year w/BME support: $500 for PM kit and FIO2 cell. Two internal batteries required every three years.	MRI conditional (3.0 Tesla 430G/cm); Air mix 21% to 100% O2; Integrated active and passive PEEP 0-20cmH2O; Low gas supply indicator; Controls for time, E time, and pressure	MRI compatible (3 Tesla 430G/cm); Air mix: 100% or 50% O2; Tidal Volume: 1300-70 ml; Low gas supply indicator; CPR ventilation setting	MRI compatible (3 Tesla 430G/cm); Air mix: 100% or 50% O2; Tidal Volume: 1500-70 ml; Low gas supply indicator	MRI Conditional; Direct-connection compatibility with vehicular and aircraft electrical systems

Table 5. Portable Ventilators: Non-MRI Conditional

	Bio-Med	Bio-Med	Draeger	Hamilton Medical	Vyaire	Vyaire	ZOLL Medical
Product	Crossvent 21+	Ventilator TV-100	Oxylog 3000 plus	HAMILTON-T1	LTV 1200	PTV ReVel	EMV+
Avg Quoted Price		$16,524	$15,666	$24,055	$13,812	$18,493	$16,985
Ventilation Modes	Assist Control: Pressure Support; SIMV; CPAP; Additional functions: Continous Flow Pressure Limit	Assist Control-Pressure Assist Control-Volume, CPAP-Pressure Backup, CPAP-Volume Backup, NIV Bi-Level, SIMV-Pressure, SIMV-Volume	VC-CMV, VC-AC, VC-SIMV, SpbCPAP, PC-SIMV+	ASV, (S)CMV+/APVcmv, SIMV+/APVsimv, PCV+, SPONT, PSIMV+, APRV, High Flow Oxygen, Speaking Valve	Assist Control/Pressure Support/Pressure Control/SIMV/CPAP/NIV/Volume Control	VC, PC, PRVC, PRVS, PS, Spontaneous, AC, SIMV, CPAP+PS, NPPV, apnea backup	Assist Control, SIMV, SIMV w/ Pressure Support, CPAP, CPAP w/ Pressure Support, Noninvasive Bilevel, Inverse Ratio
Clinical Applications	Flight medicine, Inter-hospital, Intra-hospital, Pre/Post-Op, Emergency Department	Inter-hospital, Intra-hospital, Pre/Post-Op, Emergency Department, Sub-Acute	Flight medicine, Inter-hospital, Intra-hospital, Emergency Department	Flight medicine, Inter-hospital, Intra-hospital, Emergency Department	Inter-hospital, Intra-hospital, Emergency Department, Sub-Acute, Moderate Acuity Patients, ICU, PICU, Long Term Care	Inter-hospital, Intra-hospital, Pre/Post-Op, Emergency Department, Sub-Acute, Long-Term Care	Intrahospital; pre-/post-op, ED, ICU
Monitor/Display	Exhaled Tidal Volume, Exhaled Minute Volume, Inspiratory Time, Expiratory Time, Rate, Low Battery, PEEP/CPAP, Mean Pressure, Peak Pressure, Low Supply Pressure	Exhaled Tidal Volume, Exhaled Minute Volume, Rate, FiO2, Inspiratory Pressure, Plateau Pressure, Low Battery, Tidal Volume, Max. Pressure, I:E, PEEP/CPAP, Flow Rate	MVe, FiO2, RR, VTe, PEEP, Pmean, PIP, Pplat, MVesp, RRspon, etCO2	Touchscreen: Intelligent Ventilation Cockpit, including Dynamic Lung Panel; Vent Status Panel; 39 monitored parameters	Exhaled Tidal Volume, Airway Pressure Display, Auto PEEP, Calculated Peak Flow, I:E, LTM Graphics Monitor, Mean Airway Pressure, Patient Effort, Peak Inspiratory Pressure, PEEP, Power Indicators, Static Compliance, Total Breath Rate, Total Minute Volume	Exhaled Tidal Volume, Exhaled Minute Volume, Rate, FiO2, I:E, PEEP/CPAP, MAP, Peak Insp. Flow, Spontaneous Rate, Spontaneous Vt, SpO2, pulse rate, SBT, O2 source press, battery capacity, measured leak, Pplat, static lung compliance, auto PEEP, 24 hour trending	Heart rate, O2 Sat; FiO2; PIP; PEEP; PS, Tidal Volume; Ventilation rate; I:E settings; Insp. time, Pleth; Press/Time waveform; Plateau Pressure; Tubing Compensation; leak compensation; Smart Help™ alarm mitigation
Alarms	Low Battery, High Pressure, FiO2, PEEP, Rate, Mean Pressure, Exhaled Tidal/Minute Volume, Low Supply Pressure	Tidal Volume, Low Battery, High Pressure, FiO2, PEEP, Rate, Apnea	Paw high/low, apnea back-up, leakage, high RR, etCO2 high/low, MVe high/low, supply pressure low, incorrect pressure low	Low/high MV; high pressure; low/high tidal volume, low/high rate, apnea time; low/high rate; apnea time; low/high oxygen; oxygen concentration; disconnect; loss of PEEP; exhalation obstruction; flow sensor; ASV power supply; low battery; gas supply failed	Low Battery, High Pressure, Alarm Silence/Reset, Alarm Volume, Apnea Interval, High/Low Oxygen Inlet Pressure, High/Low External Power, Low Minute Volume, Low Peak Pressure, Sense Line Disconnect, Ventilator Inoperative	Apnea, Hi/lo pressure, Hi/lo PEEP, Hi/lo pulse, Hi/lo SpO2, High rate, Low min. volume, SBT>f, SBT<f, SBT>f/Vt, SBT<f/Vt, SBT hi/lo PEEP	Lo/Med/High priority, Low Battery, High Pressure, Low Pressure; Alarm Mute/Cancel; Apnea; Low Pressure Disconnect, PEEP leak
Dimensions	Height: 10" Width: 11" Depth: 5.5"	Height 12.8" Width 11.9" Depth 7.6"	11.4 x 7.2 x 6.9 in	12" X 9" X 8"	Height: 3.25" Width: 10.50"Depth: 13.50"	11.3" x 7.1" x3.3"	Height: 12.5" Width: 7.5" Depth: 4.5"
Weight	10.50 lbs	15.60 lbs	12.80 lbs	12.30 lbs	14.50 lbs	9.50 lbs	9.70 lbs
Power Requirements	External DC: NA, Internal Battery: 6-volt rechargeable sealed lead acid, External AC Power Adapter: 100-125 VAC	External DC: NA, Internal Battery: 6-volt rechargeable sealed lead acid, External AC Power Adapter: 100-125 VAC	24V +/-6 VDC input voltage; battery: Lithium ion battery charging time 4 hrs.	AC: Standard, 115VDC: (2) Hot Swappable batteries	AC Power Adapter: 100 to 250 VACInternal Battery: Rechargeable Sealed Lead-Acid	AC: 100-240 VAC, 50-60HZ, DC: 11 to16VDC, Removable battery pack: Lithium ion 4 hour internal battery (not swappable)	External AC/DC: 11.25-30.8 VDC, Continuous Internal Battery (10 hours backup): Lithium ion, Internal 12-valve rotary compressor
Options	Air entrainment, blender, exhaled volume monitor and alarm, mounts, stand	circuits, O2 high pressure supply hose, battery charger	AutoFlow; Integrated mainstream CO2 measurement; real time data export	NEO, Capnography, APRV, DuoPAP, NIV, NIV-ST; nCPAP-PC; PDMS conectivity; loops, trending	Transport Battery System, LTM Graphics Monitor, Battery Bracket, Disposable Breathing Circuits, Electrical Strip, Floor Stand, Long Crossbar w/ Humidifier Pole, Nurse Call, Set of O2 Rings, Utility Basket	Configurable nebulizer continuous or inspirationPTM graphics monitorDocking stationRoll stand	Pole mount, wall mounting plate, roll stand, specialty mounts for stretchers and beds
Patient Population	Neonatal, Pediatric	Neonatal, Pediatric, Adult	Pediatric, Adult	Neonatal, Pediatric, Adult	Pediatric, Adult	Pediatric, Adult	Infant, Pediatric, Adult
Battery Backup	6 hours	up to 7 hours full charged	Fully charged: 7.5-9.5 hrs.	Up to 9+ hours	SprintPack Lithium-Ion Power System (4.5 lbs.) Transport Battery System (2.7 lbs.), 9-Hour Sealed Lead-Acid (26.5 lbs.) 3-Hour Sealed Lead-Acid (8.6 lbs.)	Transition battery is fully recharged within 5 hours; Removable battery pack can be recharged within 8 hours	10 hours
Gas Requirements	50 psi gas source	50 psi gas source	Supply gas: medical oxygen; pipeline system or O2 cylinder	Gas Supply operating pressure: 29-68 PSI	40-70 psig<80 lpm low pressure O2 sourceInternal blender; compressed air not required	Gas supply: oxygen/ air 20-80 PSIG	55 PSIG of O2
Other Features	Internal blender, compressor, graphics package and monitoring; Automatic altitude compensation; Interactive training/demo mode; Software upgrades via email	Internal compressor.	Pressure Support; apnea ventilation; AutoFlow; NIV; Inspiration Hold; 100% O2	Adaptive Support Ventilation; turbine-powered; w/swappable batteries; ventilation status panel. Service Cost per year w/BME support: $500 for PM kit and FiO2 cell. One internal battery required every three years.	Vent pre-sets; SBT weaning tool, internal PEEP, NPPV (NIV) mode, Apnea back-up ventilation, PC/PS variable flow termination and rise time; PS variable rise time; Leak compensation; O2 flush/cylinder duration; O2 conserve insp/exp hold	SBT- spontaneous breathing trial, Pulse oximeter, O2 flush	Airworthiness Release certification. Direct-connection compatibility with vehicular and aircraft electrical systems.

Ventilator Options

Ventilators Accessories
Sold by medical supply dealers.

Breathing circuit or ventilator circuit - Approximately $40 (for standard double limb)

Ventilator circuits with HME, filter - Approximately $50-$60.

Filter - standard $2-$8

HME (humidification) $3-$5

Ventilator rental – Ventilator rental; short term, long term; rent to own

Portable Ventilator Average Rental Rates:

Daily Rental Rate $31 -$40

Monthly $650 -950

National Medical Supply Dealers
US Med-Equip

SOMA Tech. Intl.

Med One – ventilator rental

Integrated Services/ Avante

Trace Medical

Freedom Medical

DRE Medical

Foremost Medical

Medical Device Depot

Recommendations

Given the fluid environment, understanding the current impact of patient volume and acuity, as well as the projected volume and acuity of patients is important in crisis mode resource planning.

Guidelines are being revised as new information becomes available, particularly in relation to the most effective modes and methods for ventilation in COVID-19 patients. Guideline based treatment is recommended, with a match to the most appropriate technology available at the

time of treatment. Clinically- integrated decision making is suggested for any purchase decision.

While supply and demand are likely to disrupt traditional sourcing methods, it is recommended to monitor benchmark pricing and supplier behavior during the pandemic, to potentially inform future supplier relationships. Purchasers should ensure the availability and authenticity of ancillary supplies when purchasing equipment.

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