



(REVIEW ARTICLE)



Medical support systems for childbirth in space: Equipment, drugs, and practical challenges

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Abstract

Spacefaring childbirth represents a crucial step towards humanity's expansion into a multi-planet species. This review examines the medical equipment, drugs, and support systems necessary for childbirth in space. It highlights the importance of selecting efficient equipment, addressing potential challenges, and utilizing NASA and SpaceX's technological advancements.

Keywords: Space; Childbirth; Multi-planet; Pioneering; Midwifery; Ethics

1. Introduction

As humanity ventures into space, the need for effective medical support systems during space travel becomes paramount. Childbirth in space poses unique challenges that require specialized medical equipment and support. This review explores the necessary medical equipment, drugs, and practical considerations for ensuring the safety and success of spacefaring childbirth.

2. Medical Equipment and Support System in Space Travel

In space travel, it is not feasible to provide all medical equipment and facilities. Therefore, equipment must be chosen for maximum efficiency to cover a wide range of scenarios. Diseases and medical risks should be classified based on their likelihood and potential complications. Given the constraints of space travel, reliance on available equipment in the spacecraft and telemedicine support from Earth becomes imperative. According to NASA, efficient use of limited resources is essential in prolonged space missions. This includes advanced telemedicine and portable medical diagnostic tools. For example, NASA has developed the Integrated Medical Model (IMM) to predict and manage medical events during space missions, highlighting the critical role of efficient medical equipment and support systems.

2.1. The Delivery Table in Space

A specialized delivery bed in space must be multifunctional to adapt to different childbirth positions such as lithotomy, supine, and squat. The bed should incorporate pain management techniques such as acupressure, massage, and heat therapy. Additionally, the design must emphasize reduced weight to optimize space and resource usage. SpaceX engineering expertise in creating lightweight, multifunctional equipment for its spacecraft can significantly contribute to this development. The Starship, designed for interplanetary travel, provides a stable environment suitable for medical procedures, including childbirth. Its large payload capacity ensures that necessary medical equipment can be transported efficiently.

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2.2. Possible Challenges Ahead

Childbirth in microgravity presents unique challenges. The mother astronaut must be fixed to a special bed to prevent her and the medical team from floating. SpaceX's advancements in spacecraft design are crucial in creating stable environments suitable for medical procedures. NASA research on the effects of microgravity on the human body will be essential in understanding and mitigating potential complications during space childbirth. For instance, studies have shown that microgravity affects fluid distribution in the body, muscle atrophy, and bone density loss, which could complicate the childbirth process. Developing countermeasures such as specialized exercise regimens and medication will be vital (1).

2.3. Medications and Equipment

A comprehensive list of medications, serums, and medical equipment must be prepared for space childbirth. This includes:

2.3.1 List of Medicines

- Amp oxytocin
- Amp methergine 2 mg/ml
- Prostaglandin F2 α
- Epinephrine 1:1000 vial 1 ml, 2 ml (1 mg/ml)
- Epinephrine 1:10,000 10 ml (0.1 mg/ml)
- Sodium bicarbonate 50 ml, 7.5%
- Dopamine vial 5 ml (40 mg/ml), 10 ml (40 mg/ml)
- Naloxone vial 1 ml
- Dextrose (25% and 50%) 10 ml
- Lidocaine vial ampule 5 ml (20 mg/ml)
- Atropine 10 ml (0.1 mg/ml), 5 ml (0.1 mg/ml)
- Adenosine vial 1 ml (1 mg/ml)
- Calcium chloride 10 ml
- Bretylium 10 ml (50 mg/ml), 20 ml (50 mg/ml)
- Dobutamine vial 10 ml (25 mg/ml)
- Isoproterenol vial 5 ml (0.2 mg/ml)
- Potassium chloride
- Magnesium sulfate
- Sodium heparin
- Calcium gluconate
- Reteplase
- Hypersaline
- Haloperidol
- Propranolol
- Amiodarone
- Nitroglycerin ampoule
- Verapamil ampoule
- Digoxin ampoule
- Labetalol ampoule
- Furosemide ampoule
- Midazolam ampoule
- Phenytoin ampoule
- Diazepam ampoule
- Phenobarbital ampoule
- Diphenhydramine
- Hydrocortisone
- Metoclopramide
- ASA chewable tablet 100 mg
- Clopidogrel tablet 75 ml

- Pearl nitroglycerin 0.4 mg
- Desflurane
- Droperidol
- Remifentanil
- Sufentanil
- Alfentanil
- Cisatracurium
- Etomidate
- Propofol
- Ketamine

2.3.2 *List of Serums*

- Serum Ringer
- Serum 1/3 2/3
- Serum N/S
- Serum D/W 5%
- Serum D/W 10%

2.3.3 *Large Equipment List*

- Delivery table
- Oxygen capsule for mother
- Warmer + incubator
- Suction device
- Cardiac monitoring
- Oxygen capsule for neonate
- Serum base
- CPR board

2.3.4 *List of Small Equipment*

- Ambu Bag + masks (neonate, adult)
- Laryngoscope + spare battery and lamp
- Pince Magill
- Tongue twister
- Pace maker
- Safety box

2.3.5 *List of Consumables*

- Tracheal tube number 2.5, 3, 3.5, 6.5, 7, 7.5
- NG Tube; Green, gray, blue
- Nasal catheter
- Suction tube
- Nelaton urinary catheter
- Urinary Foley catheter
- Urine bag
- Angiocatheter (Yellow, blue, pink, green, gray)
- Angioket adhesive
- Leukoplast tape
- Distilled water
- Umbilical cord clamp
- Chromic catgut suture
- Sterile gloves
- Gauze

- Betadine (Povidone-iodine)
- Hygienic pad
- Diaper
- Baby blanket
- Cold compress
- Small towel
- Infant Milk Powder Formula
- Baby Bottle
- Syringe 2 cc, 5 cc, 10 cc, 20 cc, 50 cc
- Insulin syringe
- Oral airway
- Nasal airway
- Microset
- Serum set
- Heparin lock
- Threeway stopcock
- Scalp vein
- Electrode gel
- Lidocaine gel
- Vacuum fingertip
- Suction tubing

2.3.6 *Other Supplies*

- Blood O- FFP
- Albumin 5%

2.3.7 *Sterile Delivery Set*

- Galli Pot + 9 Cotton Swaps
- Receiver + Sterile Gas
- Mayo Scissors
- Simple Scissors
- Kocher Pincers
- Pincer for Washing the Perineum
- Ring Forceps

2.3.8 *Sterile Episiotomy Set*

- Galli Pot + 7 Cotton Swaps
- Needle Holder
- Pincette
- Scissors

2.3.9 *Anaesthesia*

- Modern Anaesthesia Machine (Primus)/Continuous-flow anaesthetic machine
- I-gel
- Anaesthetic vaporizers
- Oxygen mask
- Nasal oxygen set
- Guedel airways
- Yankauer suction tip
- Peripheral venous catheter
- Ambu Laryngeal Mask Airway
- Ultra Sound Machine

- VENTILATOR
- DEFIBRILLATOR
- INFUSION PUMP
- Water & sand weight bag
- Artificial resuscitator (Bag valve mask)
- Bain circuit
- Laryngoscope
- Endotracheal tube
- Fibreoptic Intubating Bronchoscope and C-MAC Ascope
- Laryngeal mask airway (LMA) Proseal LMA
- Classical LMA
- Intubating LMA
- Endoscope
- North Pole Endotracheal Tubes
- South Pole Endotracheal Tubes
- Tracheostomy tube
- Armoured/Reinforced Endotracheal tubes
- Eschmann stylet or Gum elastic bougie
- HEPA Filter
- Hypodermic needle
- Tuohy needle
- Spinal needle
- Epidural catheter
- Syringe
- Mucus sucker
- Variable performance devices
- Fixed performance devices
- Peripheral Nerve Stimulator
- TOF Monitor
- Heart lung Machine

2.3.10 *Cesarean Section*

- Operating Scissors
- Gallipot
- Foerster Sponge Serrated
- Back Table Cover
- Basin Emesis
- Bowl
- BP Handle
- Diathermy Quiver
- Doyen Retractor
- Artery Forceps
- Forceps Green Armitage
- Tissue Forceps
- Instrument Pin
- Kocher Artery Forceps
- Serrated Dressing Forceps
- Mayo Scissors
- Ramsey Dissecting Forceps
- Needle Holder
- Towel Clamp
- Wire Basket

- Wrigley Forceps

2.3.11 D&C Kit

- Scalpel Handle #3
- Scalpel Handle #7
- Scalpel Handle #3L
- Crile Forceps Straight 6 -1/4"
- Crile Forceps Curved 6 -1/4"
- Dressing Forceps 8"
- Tissue Forceps 1x2 8"
- Crile-Murray NH Serrated 6" T-C Sklar Grip
- Mayo-Hegar NH Serrated 7" T-C
- Backhaus Towel Clamp 5 -1/4"
- Bozeman Forceps Double Curved 10"
- Foerster Sponge Forceps Curved Serrated 9-1/2"
- Jackson Retractor Small Bid 3" x 1 -1/2"
- Jackson Retractor Medium Bid 3-1/2" x 1 -1/2"
- Auvard Speculum Medium 25 lbs Bid 7x38 cm
- Graves Vaginal Speculum Medium 1 -1/4" x 4"
- Graves Vaginal Speculum Large 1 -3/4" x 4-1/2"
- Pederson Vaginal Speculum Small 1/2" x 3"
- Kogan Endospec W/Gauge & Screws
- Goodell Dilator Large 13"
- Hegar Dilators Set of 8 in Khaki Roll
- Sims Sound Pin 12-1/2"
- Sims Curette Sharp 11" #2, #3, #4, #5
- Kevork-Young Endo Curette with Basket 12"
- Schroeder Tenaculum Forceps 9-1/2"
- Javerts Forceps Serrated Jaws 9-1/2"

2.3.12 Neonate Care

- CPAP Machine
- Phototherapy Equipment
- Neonatal Ventilator
- Transport Incubator
- Resuscitation Tray
- Radiant Warmer
- Bubble CPAP
- Blood Pressure Cuffs: Neonatal, Infant
- ECG Monitor/Defibrillator with Pediatric and Adult Pads/Paddles
- Hypothermia Thermometer
- Pulse Oximeter with Pediatric and Adult Probes
- Continuous End-Tidal CO2 Monitoring Device

2.3.13 Operating Room Essential Equipment Checklist

- Anesthesia Machine
- Anesthesia Cart
- Anesthesia Circuits
- Anesthesia Monitor - CO2 and Agents
- Laryngeal Mask Airways
- Surgical Table
- Patient Stretcher

- Patient Stirrups
- Positioning Pillows
- Restraint Straps
- Patient Positioners
- Surgical Headlight
- Surgical Lights - Ceiling Mounted
- Surgical Microscope
- AED/Defibrillator
- Vital Signs Monitor
- EKG Machine
- Video Monitors and Cameras
- C-Arms
- Ultrasound Machines
- Endoscopy Tower
- Laryngoscopes
- Electrosurgical Unit
- Smoke Evacuator
- Sequential Compression Device
- Surgical Tourniquet
- Nerve Stimulator
- Blood Warmer
- Warming Air Units
- Central Gas and Suction
- Desk/Computer
- Medical Cabinetry
- Back Instrument Table
- Exchange Cart
- Hand Table
- Mayo Stand(s)
- Ring Stand
- Prep Table
- Utility Cart
- Stools (Rolling, Step, etc.)
- Linen Hamper
- IV Accessories
- Needle Counters
- Kick Buckets
- Biohazard Waste Cans
- Sponge Counter Units/Bags

2.3.14 *Hysterectomy Kit*

- Crile Forceps. 5 1/2" Cvd.6
- Allis Tissue Forceps 10" 5x6 Teeth
- Allis Tissue Forceps. 6" 4x5 Teeth
- Roch-Ochsner Forceps 1x2 Teeth 10" Str
- Roch Pean Forceps. 9" Cvd
- Roch Pean Forceps. 7 1/4" Cvd.
- Varco GB Forceps 7-1/2 Slight Curved
- Heaney-Ballantine Hysterectomy Forceps Curved. 8.25"
- Heaney Hysterectomy Forceps 2 Tooth Heavy
- Heaney Hysterectomy Forceps Curved Single Tooth 8.25"
- Heaney-Ballantine Hysterectomy Forceps Straight. 8.25"

- Schroeder Tenaculum Forceps 10"
- Braun Tenaculum Forceps. 9.5"
- Jorgeson Scissors 8.5" Strong Curved
- TC Mayo Scissors. 6 3/4" Curved Beveled
- TC Metzenbaum Scissors.11" Curved
- Operating Scissors 5 1/2" Str. Blunt/Blunt
- TC Mayo-Hegar Needle Holders 8"
- Heaney Needle Holders 8.25" Curved Jaw
- Foerster Sponge Forceps.9 1/2" Straight Serrated
- Scalpel Handle #3
- Adson Forceps 4 3/4" 1x2 Delicate Smooth 1mm
- Ferris Smith Tissue Forceps 2x3 Teeth 7"
- Russian Tissue Forceps 8"
- Potts Smith Forceps 10.25" Tc Serrated
- Selman Tissue Forceps 9.75"
- Poole Suction Tube 8 1/4" Straight 30fr
- Female Catheter 5 3/4" 14fr
- Pratt Dilator 13/15 Fr
- Pratt Dilator 17/19 Fr
- Pratt Dilator 21/23 Fr
- Auvard Vaginal Speculum 2.0 Lbs 2.75"
- Goelet Retractor 7 1/2" Double Ended
- Ribbon Retractor 13" X 1.5"
- Ribbon Retractor 13" X 2"
- Dixon Center Blades Malleable 10.5" X 2.25"
- Balfour 4th Arm Attachment Left W/O Blade 12"
- Sims Retractor Double Ended Small - 1" X 2.5" And 1.23" X 3"
- Knife Handle #3 8 3/8" Long - For Blades Styles 10, 11, 12 & 15
- Sims Sound Graduated Cm 13.5" 9.5" WL - Malleable
- Balfour Retractor Center Blade 3"X2" 7.5" Total Opening - Solid Lateral Blades 1.75" Wide X 2.5" Deep

3. Conclusion

Now we have a detailed list of equipment and supplies for spacefaring childbirth.

- Possible Challenges Ahead

Childbirth in microgravity presents unique challenges. The mother astronaut must be fixed to a special bed to prevent her and the medical team from floating. SpaceX's advancements in spacecraft design are crucial in creating stable environments suitable for medical procedures. In addition, NASA's research on the effects of microgravity on the human body will be essential in understanding and mitigating potential complications during space childbirth.

- Elon Musk and SpaceX's Contributions

Elon Musk's vision of a multi-planetary human presence is central to SpaceX's mission. The development of the Starship rocket, designed for missions to Mars and beyond, provides a stable environment for various medical procedures, including childbirth. The rocket's reusability and rapid deployment capabilities ensure that medical support systems can be efficiently transported and utilized in space.

- NASA's Role

NASA has been at the forefront of space medicine research. The Human Research Program (HRP) focuses on understanding the impacts of space on human health, while the Exploration Medical Capability (ExMC) element aims to develop clinical decision support systems and telemedicine capabilities. NASA's research on microgravity's effects on muscle atrophy and bone density loss provides critical insights for developing safe childbirth protocols in space.

Ensuring the safety and success of spacefaring childbirth requires a combination of efficient medical equipment, innovative support systems, and technological advancements from entities like SpaceX and NASA. Addressing the unique challenges of microgravity and limited resources is essential for humanity's expansion into a multi-planet species.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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