Short communication

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Lessons gleaned from the application of the Nigeria-LNG respiratory support substation in the initial short-term period at UBTH Benin-city

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Abstract

Introduction: The use of bubble CPAP devices in the management of respiratory distressed (RD) neonates in Nigeria is becoming increasingly popular. However, issues of high cost of device procurement, low overall efficiency due to poor power supply, and the need for expensive pharmaceutical surfactant, still lead to unaffordable treatments making RD associated conditions to remain the highest contributors to neonatal mortality. The need for effective and affordable alternatives in the Nigerian practice is still the gap that must be bridged for the long-awaited survival of neonates who die from some preventable causes. A new alternative approach was recently launched and applied at the Special care Baby Unit of University of Benin Teaching Hospital (UBTH).

Method: The respiratory support substation (RespSS) initiative was launched at UBTH and operated based on the algorithms of the politeheartCPAP® machine and other accompanying technologies within the installed RespSS. Patients were randomly assigned to the substation with ten cases being sub-admitted in the first 10 weeks after the launch of the RespSS. Most of the treated cases were of extremely-low birthweight or extremely preterm categories (25-26w GA, 680-1080g BW). Surfactant application was not compulsorily required and respiratory nasal cannula of <$0.5 was the only consumable requirement for the RespSS treatment.

Results: All the ten cases were successfully treated and sub-discharged from the RespSS in <10 days except the first three cases whose admissions occurred during the initial learning period on how to manage neonates in the RespSS.

Conclusion: The short-term outcome of the RespSS is a compelling eye-opener at the UBTH Centre. The RespSS idea could be the long-awaited game changer for the Nigerian and LMIC neonate.

Keywords: RDS, respiratory support, neonate, LMIC, neonatal mortality, surfactant

Introduction

Neonatal respiratory support refers to interventions aimed at assisting and improving breathing in newborns.[1] Many hospitals lack respiratory support facilities such as bag and mask devices, standard continuous positive airway pressure (CPAP) devices and ventilators for the management of neonatal respiratory distress syndrome (RDS).[2]

The University of Benin Teaching Hospital (UBTH), a tertiary health facility in Edo state Nigeria, operates with both basic amenities like bag and mask devices, and advanced equipment like bubble continuous positive airway pressure (bCPAP) devices and ventilators. However, just like every other health facility in low resource countries, many other factors come into play in the eventual outcome of babies accessing these respiratory support devices. Such factors include availability of constant electricity and oxygen supply to power the devices, limited number of devices to monitor all babies on these machines in real time, availability of one-use consumables amidst others.

The new Nigeria liquefied natural gas (NLNG) installations

The PoliteheartCPAP machine[3] was brought into the Neonatal Unit of UBTH on the 11th of September 2024, and hardware installation was completed two days after.

On the 14th of September, there was a training of doctors from the various cadres, nurses and respiratory support staff of the Unit, by the NLNG ambassador, who led the project.

The ambassador exhibited mastery as he highlighted the unique benefits of having this set up viz a viz: low cost of use for the hospital and the patient, delivery of appropriately warmed air-oxygen mixture under pressure to the neonate which have been shown by research to improve outcomes, and real time monitoring of feedback from the babies, minimizing the risk of oxygen toxicity.

Feedback from the training attendees showed that the basic principles were well understood, hence, the need to put the substation to use for impact assessment on the neediest neonates. It is understood that RDS in the newborn is often a secondary high- mortality condition because of some other underlying conditions that require urgent attention. Therefore, the fundamental assessment of the respiratory support substation was to investigate how well the substation's devices are able to breathe for the neonate until the underlying conditions militating against independent breathing are resolved, or for the extremely-preterm/extremely-low birthweight (ELBW, <32 weeks GA or <1000 g BW) neonate to be kept alive until sufficiently matured to begin to learn how to breathe and graduate unto unassisted-breathing. Confirmed mortalities outside these fundamental functions of the installed technologies are not regarded as the failures of the substation initiative.

Methods

After the theoretical discussion, hands-on training was done at the substation and the index patient was put on the machine as led by the NLNG ambassador (Figure 1).

Figure 1 UBTH, Benin-city substation.

The patient was managed jointly as participants learned the required practical skills for the operations of the substation, and subsequently took over the full operations of the substation.

Baby N. was a 4-day old 800g male neonate, born at 28 weeks gestation, who had respiratory distress syndrome (RDS). As at that time, he was the neediest baby in the Special Care Baby Unit (SCBU), and the only patient who benefited whilst the ambassador was still on call. He had had surfactant administered within the first 24hrs of life, prior to the installation of the NLNG politeheartCPAP machine, and was at the time of transition to the machine having oxygen saturation levels of 96-99% at an oxygen flow rate of 3L/min through improvised-CPAP device. He was also being managed for sepsis.

On the politeheartCPAP, initial machine settings were put at 'positive end expiratory pressure (PEEP)' of 7cmH_2O, an oxygen flow rate of 3L/min and air flow rate of 3L/min, yielding a 'fraction of inspired oxygen (FiO_2)' of 51%, which was immediately displayed on the device digital screen. The baby was strapped into the continuous monitoring inbuilt device of the politeheartCPAP system for Heart-rate and Oxygen saturation, and subsequently machine settings were adjusted based on feedback from the pulse oximeter.

The equipment was properly handed over to the managing consultants, with full involvement of the nurses, electrical and biomedical engineers from UBTH, respiratory support staff and the hospital management team. After the index patient, nine more babies benefited from the politeheartCPAP device leading up to the time of this report. These include Baby-B1 and Baby-B2, who are twin male preterm, extremely low birth weight infants delivered at 25 weeks of gestational age (GA). The 4th benefitted patient was a 34-weeks GA male neonate. The 5th and 6th were IVF twin male, delivered at 26 weeks GA and weighing 1000g and 1080g, respectively, who were placed on the politeheartCPAP immediately after birth without the administration of surfactant as the device is characterized to preserve and sustain the natural surfactant production in the neonate.

The twins (B1 and B2) were given surfactant within the first 24 hours of life as consented by parents and commenced on respiratory support at 36.5°C inspiratory gas temperature, with a positive end expiratory pressure (PEEP) of 6 cmH2O, oxygen flowrate of 3 LPM and airflow of 3 LPM. They were connected to their individual monitors and respiratory chart records were opened for them.

Results

Following the placement of baby N on the machine, there was a reduced work of breathing for the neonate. And within 2hrs, machine settings have been stepwise and progressively adjusted down to 4cmH_2O PEEP, 1L/min oxygen flowrate and FiO2 of 27%, which is close to atmospheric air.

Within 4hrs, baby N had been successfully weaned off oxygen and was saturating at 93-96% on warmed pressurized air flowing at 4L/min and a PEEP of 4cmH_2O. By the 3rd day on the Politeheart machine, the baby was running on only heated atmospheric air (unpressurized end-expiratory-gas) with good oxygen saturation above 93%. Baby N was subsequently progressed algorithmically to independent effortless breathing on the 4th day of treatment. However, on the 2nd day of independent breathing, neonate was further diagnosed with bleeding problems and had to be returned for the politeheartCPAP assisted breathing whilst the clinical team made efforts to resolve this problem. Baby-N finally succumbed to sepsis with DIC on the 20th day of life, having obviously lived this long because the politeheartCPAP efficiently supported him whilst the medical team tried to resolve his complications.

The twin neonates (Baby-B1 and Baby-B2) progressed significantly in quick time. By the third day of life, they had been successfully weaned off oxygen and were on gradual weaning from pressurized air for 10 more days. By the 13th day of life, they had frequent episodes of apnoea of prematurity, necessitating the recommencing of supplemental oxygen at flowrates as low as 1.5L/min. The duration of administration of xanthine was also extended. By 36 days after birth both twins were responding favorably having been weaned off the politeheartCPAP for unassisted breathing.

A total of ten patients have so far been admitted at the substation, 10 weeks leading up to the submission of this manuscript, and all ten were successfully treated and sub- discharged back into the SCBU hall for the continuation of their special care.

Discussion

Neonatal mortality trends in Nigeria have shown respiratory distress to be a leading cause.[4] If more babies could get access to low-cost respiratory support technologies tailored to thrive in such low resource settings as ours, whilst being shielded from hypothermia and oxygen toxicity—just like the politeheartCPAP device has demonstrated—we may be able to rescue more of the distressed neonates, irrespective of their categories of prematurity.

A few administrative issues in our SCBU delayed the expected high traffic of needy neonates for sub-admission leading to only four treated cases in the first seven weeks following installation and training. However, our first three cases fall within the most difficult to manage categories of prematurity—our baby-N being 800 g and 28 weeks of gestation, baby-B1 and baby-B2 being 25 weeks of gestation, respectively. These are cases typically known in our SCBU to require longer periods to attain sufficient maturity for unassisted breathing. Nevertheless, the substation achieved 100% success rate on its fundamental service for these tough patients. In each of these cases, the external consumable cost to parents was <$0.5 (nasal cannula only, additional surfactant administration was not required for consenting parents) as compared to other not-so- effective devices, applications, and procedures in our Centre requiring consumables in excess of unaffordable $300. In the short time of using the NLG installed PoliteheartCPAP machine and other accompanying systems such as the politeoxygen- splitter-system[5] and the polite-light-bank,[6] the initial positive impact on patient recovery and longevity seems to suggest that this may become the sustainably affordable way to help more babies survive from RDS in Nigeria and the LMICs. We look forward to having more data emanate from the substation's usage to support this claim.

One of the unique learning points for the care staff was the knotting of nasal prongs at the top of the head and not the nape of the neck as we habitually did at our Centre.

Another essential lesson was the unique algorithmized technique of weaning a neonate off the politeheartCPAP. This is scientific, methodical and efficient, with seamless steps strictly driven by real-time changing values of the patient's physiological parameters, and completely different from how we did this on other applications in our Centre.

Conclusions

An important lesson from the short usage of the installed devices is that not all babies receiving oxygen therapy in Nigeria actually need it. All they seemed to need, after initial stabilization to zero supplemental oxygen requirement, might just be warm pressurized air while they learned how to breathe independently on atmospheric air. As clinicians, we hope to see how we can explore this and help more babies to live and not die.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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