ORIGINAL ARTICLE

Mechanical Ventilation of Neonates at the University Hospital of the West Indies 1987–2015

H Trotman, O Olugbuyi

ABSTRACT

Aim: *To compare present trends in utilization of the neonatal intensive care unit (NICU) with trends seen during the period when neonates were ventilated in the main intensive care unit of the University Hospital of the West Indies.*

Methods: *Data from previously published studies on outcome of neonates ventilated at the main intensive care unit 1987–2001, the neonatal intensive care unit 2002–2004 and the annual perinatal statistics (2006–2010, 2015) were reviewed to detect trends in mechanical ventilation, utilization and outcome. Descriptive analyses were performed.*

Results: *The number of neonates mechanically ventilated per thousand admissions increased from 10/1000 in the 1990s to 73/1000 in 2015. Percentage mortality for ventilated neonates increased from 51% between 1987–1991 to 62 % in 2015. The proportion of extremely low birthweight infants (< 1000 g) mechanically ventilated increased from 29% in 1987–1991 to 50% in 2015. The percentage mortality for extremely low birthweight infants increased from 17.5% in 1987–1991 to 40.6% in 2015. The percentage mortality for all other birthweight categories decreased over time. Respiratory distress syndrome remains the major reason for neonates requiring mechanical ventilation. Fifty per cent of neonates < 1500 g ventilated for respiratory distress syndrome received surfactant replacement therapy.*

Conclusion: *Access to mechanical ventilation by neonates has increased tremendously at the University Hospital of the West Indies. The present challenge, however, is decreasing mortality in these neonates who access this technology.*

Keywords: Neonatal Intensive Care Unit, neonatal mortality, NICU outcome, neonatal ventilation

Ventilación Mecánica de Neonatos en el Hospital Universitario de West Indies 1987–2015

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RESUMEN

Objetivo: *Comparar las tendencias actuales en la utilización de la Unidad de Cuidados Intensivos Neonatales (UCIN) con las tendencias observadas durante el período en que los neonatos eran ventilados en la Unidad Principal de Cuidados Intensivos del Hospital Universitario de West Indies.*

Métodos: *Se revisaron los datos de estudios publicados anteriormente sobre el resultado clínico de los neonatos ventilados en la Unidad Principal de Cuidados Intensivos en 1987–2001, La Unidad de Cuidados Intensivos Neonatales en 2002–2004 y las y las Esta-*

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dísticas Perinatales Anuales (2006–2010, 2015) con el propósito de detectar las tendencias en la utilización y los resultados de la ventilación mecánica. Se realizaron análisis descriptivos. ***Resultados:*** *El número de neonatos ventilados mecánicamente por cada mil ingresos aumentó de 10/1000 en la década de 1990 a 73/1000 en 2015. El porcentaje de mortalidad de neonatos ventilados aumentó de 51% entre 1987–1991 a 62% en 2015. La proporción de neonatos de peso extremadamente bajo al nacer (< 1000 g) ventilados mecánicamente aumentó de 29% en 1987–1991 a 50% en 2015. El porcentaje de mortalidad de recién nacidos de peso extremadamente bajo al nacer aumentó de 17.5% en 1987–1991 a 40.6% en 2015. La mortalidad porcentual para todas las otras categorías de peso al nacer disminuyó con el tiempo.*

El síndrome de dificultad respiratoria sigue siendo la razón principal por la que los neonatos requieren ventilación mecánica. El cincuenta por ciento de los neonatos < 1500 g ventilados por el síndrome de dificultad respiratoria recibió terapia de reemplazo de surfactantes. ***Conclusión:*** *El acceso a la ventilación mecánica por los neonatos ha aumentado enormemente en el Hospital Universitario de West Indies. No obstante, el reto actual es disminuir la mortalidad de los neonatos que acceden a esta tecnología.*

Palabras clave: Unidad de Cuidados Intensivos Neonatales, mortalidad neonatal, resultados de la UCIN, ventilación neonatal

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INTRODUCTION

Neonatal mortality has been shown to decrease with the advent of mechanical ventilation and neonatal intensive care measures (1, 2). Chow *et al* conducted a selective review of mortality in neonatal intensive care units [NICUs] (3). They found that there was a wide variation in the mortality rate among NICUs and between developed and developing countries, with rates ranging from 4 to 46% in developed countries and from 0.2 to 64.4% in developing countries (3).

Provision of ventilatory support for neonates at the University Hospital of the West Indies (UHWI) has evolved from its crude beginnings of provision of supplemental oxygen in the sixties to the provision of mechanical ventilation in a six-bed neonatal intensive care unit (NICU) today. Lowry spoke to the provision of positive end-expiratory pressure in the treatment of respiratory distress syndrome [RDS] (4), no doubt this was genesis of the use of bubble continuous positive airway pressure (CPAP) prevalent at the UHWI in the eighties, nineties and up to today.

Prior to August 2001, there were no ventilatory facilities attached to the neonatal unit, neonates who required mechanical ventilation were ventilated in the main eight-bed ICU which serviced the entire UHWI patient population consisting mainly of adults requiring medical and surgical interventions. Neonates were co-managed by the paediatricians and anaesthetists. Neonates who did not gain entry to the ICU and required ventilatory support were managed on the neonatal unit with bubble CPAP. In August 2001, a newly refurbished and reconfigured neonatal unit was opened which consisted of a 30-bed level II special care nursery and a six-bed level III NICU with the neonates being managed by the paediatricians/neonatologists. Presently up to five neonates can be ventilated at any point in time.

The use of bubble CPAP at the UHWI has been a constant throughout but over the past 10 years with the global trend in neonatal intensive care towards non-invasive ventilation it has once again become a prominent method of offering ventilatory support. During the five-year period (2006–2010), 453 neonates received ventilatory support at the UHWI, 49% *via* bubble CPAP. Surfactant replacement therapy (SRT) used in the management of premature infants with respiratory distress syndrome (RDS) was first used at the UHWI in 2002. Total parenteral nutrition for the neonates has been inconsistently available in recent years.

The end of 2016 marked 15 years of mechanically ventilating neonates in the NICU, it is therefore an opportune time to compare present trends in mechanical ventilation, utilization and outcome with those seen in the previous 15 years when neonates were mechanically ventilated in the main ICU of the UHWI.

SUBJECTS AND METHODS

Data from previously published studies on outcome of neonates ventilated at the main ICU UHWI 1987–2001 (5), the NICU 2002–2004 (6) and the annual perinatal statistics for the UHWI (2006–2010, 2015) were

reviewed to detect trends in mechanical ventilation, utilization and outcome at the UHWI.

Statistical analysis

Descriptive analyses were performed; mortality was expressed as percentages and rates. Differences in mortality by weight categories were analysed and trends described. Changes in causes of mortality over the time were also documented.

Ethical approval

The University of the West Indies, Ethics Committee, Mona, Jamaica, granted approval for the use of data collected for the annual perinatal audit at the UHWI.

RESULTS

The number of neonates mechanically ventilated per thousand admissions at the UHWI has increased from 10/1000 in the 1990s to 73/1000 in 2015 (Fig.1).

Concomitantly, percentage mortality for ventilated neonates decreased from 51% between 1987–1991 to 36% during the period 2002–2004, but subsequently in the latter years 2006–2010 and 2015 mortality increased to 62% (Fig. 2).

The proportion of extremely low birthweight ELBW infants (birthweight < 1000 g) mechanically ventilated ranged from 29% in 1987–1991 to a high of 50% in 2015 (Fig. 3).

Similarly, the proportion of neonates ≥ 2500 g ventilated increased from 19% to 31%. Very low birthweight VLBW infants (birthweight < 1500 g) ventilated ranged from 54% in 1987–1991 to a high of 71% during the period 2006–2010 and subsequently decreased to 56%.

The percentage mortality for ELBW infants increased from 17.5% in 1987–1991 to 40.6% in 2015 (Fig. 4).

The percentage mortality for all other birthweight categories has decreased over time, however, neonates

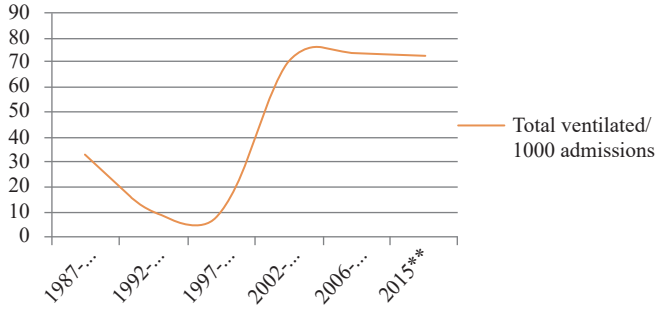

Fig. 1: Mechanically ventilated neonates per 1000 admissions at the UHWI 1987–2015.

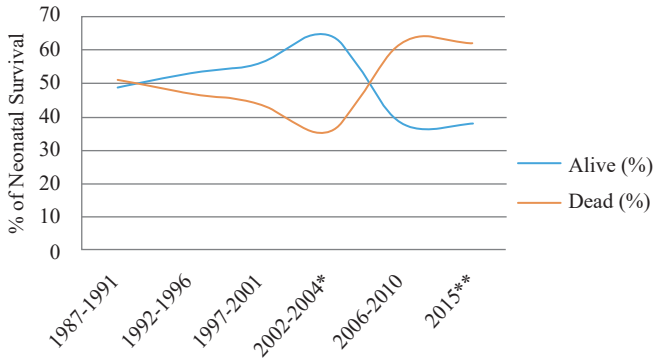

Fig. 2: Outcome of mechanically ventilated neonates at the UHWI 1987–2015.

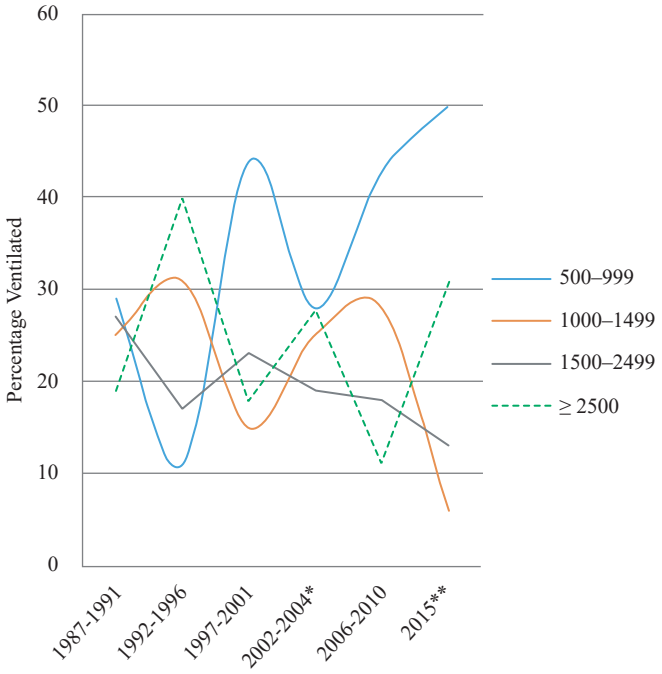

Fig. 3: Percentage mechanically ventilated neonates by birthweight at the UHWI 1987–2015.

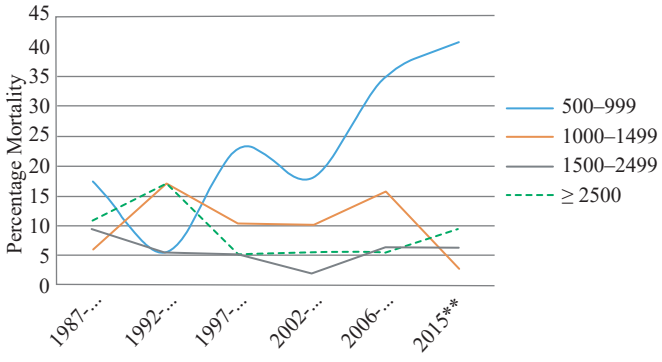

Fig. 4: Percentage Mortality by birthweight of mechanically ventilated infants at the UHWI 1987–2015.

< 1500 g account for 60% of mortality of ventilated neonates at the UHWI. The major reason across the decades for neonates requiring mechanical ventilation at the UHWI has been respiratory distress syndrome [RDS] (Table 1).

Table 1: Main reasons for mechanical ventilatory support in neonates ventilated at the UHWI (1987–2015)

Cause	1987–1991	1992–1996	1997–2001	2002–2004*	2006–2010	2015**
RDS	59 (75)	19 (53)	25 (64)	87 (63)	159 (68)	21 (66)
HIE	6 (8)	3 (8)	3 (8)	15 (11)	-	4 (13)
MAS	7 (9)	4 (11)	1 (3)	11 (8)	-	1 (3)

*3 years **1 year
RDS; Respiratory distress syndrome, HIE; hypoxic ischaemic encephalopathy, MAS; Meconium aspiration syndrome

Prior to 2002 no neonate received surfactant replacement therapy (SRT) at the UHWI. During the period 2002–2004 twenty-eight (38%) VLBW infants who were mechanically ventilated received SRT, during the period 2006–2010 eighty-one (50%) VLBW infants who were mechanically ventilated received SRT.

DISCUSSION

Neonatal access to mechanical ventilation tripled from the initial period (1987–2001), when they were ventilated in the main ICU, to the current time (2015) when respiratory support is provided in the NICU. This is expected since, during the initial period, the main ICU at the UHWI offered a limited eight-bed unit that serviced the entire hospital. Prior to the establishment of the NICU, inadequate beds and human resources constrained accommodation of neonates in need of ventilatory support, additionally neonates competed with older children and adults for the limited resources. The NICU being a dedicated intensive care unit for neonates affords them more access to mechanical ventilation.

The mortality rate for neonates ventilated at the UHWI fell steadily by 30% until 2002–2004 but in the subsequent five years it increased beyond that noted for the period 1987–1991. This reversal may well be related to the increased number of ELBW and VLBW infants ventilated in the latter time period (2006–2010 and 2015) as these infants are at increased risk of mortality. The biological basis for their elevated mortality risk relates to immaturity, a high incidence of RDS and susceptibility to sepsis. Although, the mortality rate was high, a greater number of neonates were ventilated in the latter years hence a substantial number of neonates benefitted from mechanical ventilation on the NICU at the UHWI.

Respiratory distress syndrome was the major reason for neonates requiring ventilatory support. This is consistent with other centres in lower and middle-income countries (7, 8). This finding is not surprising as RDS is primarily a disease of premature infants, particularly ELBW and VLBW infants who lack pulmonary surfactant production at birth which results in difficulties in oxygenation and ventilation. This leads to the requirement for ventilatory support. The increased percentage of babies being ventilated because of RDS in the latter years is a reflection of the increased number of ELBW and VLBW infants being ventilated at that time period.

Surfactant replacement therapy significantly improves the survival of neonates with RDS (9, 10). At the UHWI, there may be a surfactant-ventilatory gap as it is use, although increasing, has not kept pace with the increase in the number of ELBW and VLBW infants presently being ventilated at the UHWI. It is essential that accessibility to this critical therapy be increased to improve the mortality of infants.

The low ventilation per admission rate of the period 1987–2001 mandated the need for establishing a NICU at the UHWI and the utility of this intervention has been proven by the tremendous increase in the number of neonates accessing mechanical ventilation with the advent of the NICU at the UHWI. The present unacceptably high mortality rate for ventilated infants, however, now mandates the need for interventions to increase survival in order for the NICU to be a cost-effective, sustainable venture. Decreasing mortality in neonates < 1500 g who account for 60% of mortality and particularly the 'micro-preemies' (< 1000 g) must be at the heart of the post NICU implementation agenda at the UHWI.

These interventions must include defining an evidence-based age of viability for neonates at the UHWI as this can guide policy on which neonates stand to truly benefit from the intervention of mechanical ventilation in the face of budgetary constraints. There must be effective triage at the threshold of viability based on probable futility of care. Evidence-based protocols must be developed for the management of the micro preemie. Outborn neonates must be transported in a stable, controlled environment so they can adequately benefit form neonatal intensive care measures offered at the UHWI. The provision of adequate numbers of appropriately trained staff dedicated to the NICU must become the norm so that the recommended nursing staff to neonate ratio is

maintained at all times. Adherence to stringent measures for infection control must continued.

Finally, supporting technologies that are critical in the management of ELBW and VLBW infants such as total parenteral nutrition and surfactant replacement therapy must become standard of care. Strategic policy positioning such as advocating for surfactant to be free of cost at the UHWI as presently occurs at public facilities will foster equity in access to this therapy for all Jamaican neonates regardless of the hospital of birth. This may result in a decrease in future social health disparity. Future cost benefit analyses may provide further evidence for rationale policy development. All these measures will require political will and the consistent provision of required resources to facilitate targeted improvement.

CONCLUSION

Access to mechanical ventilation by neonates has increased tremendously at the UHWI. The present challenge, however, is decreasing mortality in these neonates who access this technology.

Authors contribution

H Trotman conceived the paper, oversaw the data collection, wrote the manuscript and approved the final version. AO Olugbuyi participated in analysis and critical review of the manuscript and approved the final version.

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