


# Cost of nitric oxide therapy in neonates

Emily Hoyle , Hannah Spierson, David Cordon, Joanne Brady, Nimish V Subhedar

**To cite:** Hoyle E, Spierson H, Cordon D, *et al.* Cost of nitric oxide therapy in neonates. *BMJ Paediatrics Open* 2020;**4**:e000776. doi:10.1136/bmjpo-2020-000776

Received 23 June 2020  
Accepted 3 September 2020

## ABSTRACT

A retrospective observational cohort study was performed to review the cost of inhaled nitric oxide (iNO) therapy in a UK neonatal intensive care setting over a 4-year period. 188 neonates with a median (IQR) gestational age and birth weight of 27 (24–37) weeks and 980 (695–2812) g, respectively, were treated with iNO. The median (IQR) duration of iNO therapy was 60 (22–129) hours. The mean cost of iNO therapy was approximately £820 per baby treated equivalent to £8.50 per hour of therapy. Alternative pricing models suggested a calculated cost of iNO therapy of between approximately £950 and £1350 per baby.

We conducted a study to determine the cost of inhaled nitric oxide (iNO) therapy in a neonatal intensive care unit and provide novel data on the current cost of such therapy in the UK.

iNO is a selective pulmonary vasodilator that has become part of the standard management for neonatal hypoxaemic respiratory failure and/or pulmonary hypertension.<sup>1</sup> It is licensed for use in the treatment of newborn infants  $\geq 34$  weeks' gestation with hypoxic respiratory failure<sup>2</sup> but is also commonly used off-label in preterm infants  $< 34$  weeks' gestation. There are limited, historical, data relating to the overall costs of iNO therapy in neonates and none providing information at an individual baby level.<sup>3,4</sup>

A retrospective observational cohort study was performed to review the use of iNO in our neonatal unit to calculate the costs of providing therapy in a neonatal care setting.

Our institution is a tertiary-level regional referral centre, accepting approximately 1000 term and preterm admissions per annum. Babies with antenatally diagnosed structural cardiac defects are delivered and receive initial stabilisation at our institution, prior to transfer to a cardiac surgical centre. In our unit, iNO is used in the management of ventilated term and preterm infants with hypoxaemic respiratory failure. We do not offer an extracorporeal membrane oxygenation service.

All newborn infants who were treated with iNO at Liverpool Women's Hospital over a 4-year period (between April 2016 and March

2020 inclusive) were included and identified using local data submitted to the European iNO Registry (<https://www.medscinet.net/ino/>).

Information on the total cost of iNO therapy, including number of gas cylinders used, rental charges for cylinders, monitoring/delivery equipment and cost of consumables was obtained from hospital finance records for this period. Using this information, we calculated the mean annual actual cost of providing iNO therapy using our commercial supplier which charged on the basis of total number of individual items used (BTG Gases, SOL Group, Monza, Italy).

We also created two models to reflect alternative pricing structures offered by the other UK supplier of iNO during the study period (INO Therapeutics, Sittingbourne, UK). Model A provided a complete rental package for iNO gas and all equipment using an hourly charge basis of £23.10 per hour, which included a volume discount of 15% based on the previous year's usage, capped at a maximum of 96 hours treatment. Model B charged on the same basis as our own supplier with separate elements to be purchased including the gas itself, cylinder rental charge and cost of consumables.

One hundred and eighty-eight neonates were treated with iNO during this study period; seven babies received two courses. Their median (IQR) gestational age and birth weight were 27 (24–37) weeks and 980 (695–2812) g, respectively. During this time, a total of 18 078 hours of iNO therapy was used. The median (IQR) duration of iNO therapy was 60 (22–129) hours.

The cost of iNO therapy and the calculated costs using the two other models are shown in [table 1](#).

There are relatively few studies describing the cost of individual drugs commonly used in neonatal practice. Along with surfactant, our data indicate that iNO is one of the most expensive drugs routinely offered to neonates.<sup>5</sup>

Data from this study are likely to be useful to individual neonatal providers and healthcare



© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

Neonatal Unit, Liverpool Womens Hospital NHS Foundation Trust, Liverpool, UK

## Correspondence to

Dr Nimish V Subhedar; Nim. Subhedar@lwh.nhs.uk

**Table 1** Actual cost of iNO and comparison with other UK pricing models

	Actual cost	Pricing model A	Pricing model B
Mean cost (per annum)	£38 414	£44 985	£63 308
Mean cost (per hour)	£8.50	£9.95	£14.00
Mean cost (per treatment episode)	£787.98	£922.76	£1298.63
Mean cost (per baby treated)	£817.32	£957.12	£1346.98

iNO, inhaled nitric oxide.

commissioners to inform budgeting and expenditure. Additionally, an accurate estimation of the overall costs of iNO therapy is essential for health economic research studies evaluating the cost-effectiveness of therapeutic interventions in neonatal care.

**Correction notice** This article has been corrected since it was first published.

**Contributors** EH was responsible for conducting, data collecting, analysing, reporting and preparing the manuscript for publication. NVS was responsible for planning, reporting, analysing and preparing the manuscript for submission. HS was responsible for data collecting and reporting. JB was responsible for data collection. DC was responsible for data collection.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** Until December 2019, NVS chaired the European Inhaled Nitric Oxide Registry which was commercially funded by a variety of suppliers of inhaled nitric oxide, none of which had a role in this study.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iD

Emily Hoyle <http://orcid.org/0000-0001-9265-3794>

#### REFERENCES

- 1 Sokol GM, Konduri GG, Van Meurs KP. Inhaled nitric oxide therapy for pulmonary disorders of the term and preterm infant. *Semin Perinatol* 2016;40:356–69.
- 2 European medicines Agency, INOmax, summary of product characteristics. Available: <https://www.ema.europa.eu/en/medicines/human/EPAR/inomax>
- 3 Konduri GG, Menzin J, Frean M, *et al*. Inhaled nitric oxide in term/late preterm neonates with hypoxic respiratory failure: estimating the financial impact of earlier use. *J Med Econ* 2015;18:612–8.
- 4 Subhedar NV, Jauhari P, Natarajan R. Cost of inhaled nitric oxide therapy in neonates. *Lancet* 2002;359:1781–2.
- 5 Brown S, Hurren J, Sartori H. Poractant alfa versus Beractant for neonatal respiratory distress syndrome: a retrospective cost analysis. *J Pediatr Pharmacol Ther* 2018;23:367–71.