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ORIGINAL ARTICLE

Improving accuracy of outcome prediction for infants born extremely preterm using a digital tool: Translating 'NIC-PREDICT' into clinical practice, the first steps

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Background: Many clinicians overestimate mortality and disability rates in infants born extremely preterm. We developed a digital tool ('NIC-PREDICT') that predicts infant mortality and survival with and without major disability in infants born 23–27 weeks' gestation.

Aims: To determine if clinicians could use NIC-PREDICT accurately, and if their perceptions of infant outcomes improved after its release in 2021.

Materials and Methods: Midwives, nurses, obstetricians, neonatologists and paediatricians working in tertiary and non-tertiary hospitals in Victoria were asked to use NIC-PREDICT to estimate three mutually exclusive outcomes: (i) mortality; (ii) survival free of major disability; and (iii) survival with major disability for six different scenarios where a liveborn infant was offered survival-focused care after birth. The proportions who completed the survey (responded to all six scenarios) and the proportions able to provide 100% accurate results for all scenarios were determined. Estimates of the three outcomes were compared with true rates.

Results: A total of 85 clinicians responded: 70 (82%) completed the survey, with an overall accuracy of 76%. Overall, predictions of mortality were accurate (mean difference from true value 0.7% (95% confidence interval (CI) −0.7, 2.1) $P = 0.33$), as were predictions of survival without major disability (mean difference − 0.7 (95% CI –3.0, 1.7) $P = 0.58$). However, survival with major disability was overestimated by 4.9% ((95% CI 1.7, 8.0) $P = 0.003$).

Conclusions: Most perinatal clinicians who responded used NIC-PREDICT correctly to estimate expected outcomes in infants born extremely preterm who are offered intensive care. Undue pessimism about survival with major disability remains an ongoing concern.

KEYWORDS

developmental disabilities, extremely premature, infant mortality, neonatal intensive care, preterm infant, prognostic factors

NIC-PREDICT is available at https://nic-predict.com.au.

INTRODUCTION

The outcome for infants born extremely preterm (EP; <28 weeks' gestation) depends heavily on clinical decision-making both before and after birth.[1,2] Perinatal interventions provided before birth, including exposure to antenatal corticosteroids and magnesium sulphate, and in utero transfer to facilitate birth in a tertiary perinatal centre are associated with either increased survival rates, or with lower risk of major neurosensory disability in surviving children born EP.[3–5] Without survival-focused ('active') care after birth, including supporting breathing, maintaining normal body temperature, and providing adequate nutrition, infants born EP will die. Hence if parents want survival-focused care for their infant, providing a suite of perinatal interventions is essential to optimise infant outcomes. This requires a collaborative approach to parental counselling, decision-making, and care by the obstetric and neonatal teams before the infant's birth.[6,7]

To provide parents with realistic expectations regarding infant survival and disability risks, clinicians need accurate knowledge of these outcomes. However, previous studies, including our own, consistently demonstrate that many perinatal clinicians, from all disciplines (obstetrics, neonatology, paediatrics, nursing, and midwifery) underestimate survival chances and overestimate disability risk in infants born EP.[8–11] Moreover, in our most recent survey conducted in 2020[11] we found that clinicians' ability to predict infant outcomes accurately was worse than it was in our previous study conducted a decade earlier.[10] These studies raise the possibility that some parents may be making life-and-death decisions for their infants based on inaccurate and overly pessimistic prognostication of infant outcomes.

To address this problem, we developed a smartphone application ('app') and web-based tool, NIC-PREDICT to predict outcomes in infants born EP who are offered active care. The tool predicts the three mutually exclusive outcomes for livebirths at 23–27 weeks' gestation who are offered active care: (i) mortality, (ii) survival free of major neurosensory disability, and (iii) survival with major neurosensory disability. As the first steps in evaluating the translation of NIC-PREDICT into clinical practice, the aims of this study were to determine if clinicians could use NIC-PREDICT accurately, and if their ability to predict infant outcome was more accurate compared with their predictions prior to the availability of NIC-PREDICT.

MATERIALS AND METHODS

Development of NIC-PREDICT

Data on infant survival and major disability rates were derived from two population-based data collections, both with prior ethical approval. The survival data for NIC-PREDICT were obtained from a whole of population cohort of 2048 livebirths at 23–27 weeks' gestation in the state of Victoria in 2009–2017 who were offered active care after birth. The variables independently associated with mortality by one year were lower gestational age, male sex, non-tertiary ('outborn') birth status, and no antenatal corticosteroid exposure, as determined by multivariable logistic regression using Stata 14 (StataCorp, College Station, TX, USA). Birth weight, plurality, and small-for-gestational age status were not independently associated with infant mortality in this cohort.

Rates of major neurosensory disability were derived from outcomes to eight years of age of survivors born <28 weeks' gestation in the state of Victoria in 1991–92, 1997 or 2005.[12,13] Major disability comprised any of moderate/severe cerebral palsy (unable to walk or walking with considerable difficulty with or without a walking aid; Gross Motor Function Classification System score level ≥ 2), blindness, deafness, or an Intelligence Quotient score < −2 relative to term born controls.

Using the coefficients for the independently predictive variables and the constants from the logistic regressions, the probabilities of the three mutually exclusive outcomes of death, survival free of major disability and survival with major disability at each week of gestational age were calculated for inborn and outborn males, with or without antenatal corticosteroids and inborn and outborn females, with or without antenatal corticosteroids. These data were used to create the algorithms for NIC-PREDICT's calculations for individual infants. If infant sex is unknown prior to birth, entering 'male' provides lower estimates of survival, and entering 'female' provides higher estimates.

The NIC-PREDICT smartphone app was released for clinical use in the state of Victoria on 17/7/2021. Information about its availability for use was promoted at perinatal conferences and seminars, and at local grand rounds in tertiary and non-tertiary hospitals. The web-based version first available in late 2020 had already been recommended as a tool to assist in perinatal counselling in the statewide Extreme Prematurity Guideline, published by Safer Care Victoria in December 2020.[14]

Improving accuracy of outcome prediction of EP infants using NIC-PREDICT

One year after NIC-PREDICT became available, ethics approval from the Royal Children's Hospital (Study ID HREC/65384/RCHM) was obtained for a follow-up study to determine if: (i) clinicians could more accurately predict infant outcome using NIC-PREDICT, and (ii) to explore characteristics of respondents who did or did not predict outcome accurately using the app.

We sent an electronic REDCap® survey to midwives, nurses, obstetricians, paediatricians, general practitioners and neonatologists working in tertiary and non-tertiary hospitals in Victoria who care for pregnant women or preterm infants, or who are involved in maternal or neonatal emergency retrieval. These were the same groups of health professionals we targeted in the previous surveys. The Medical Directors of each unit and nurse unit managers in the non-tertiary units were asked to distribute the survey to their staff, so we do not know the true number who might have received it. Clinicians were asked to use NIC-PREDICT to estimate the three mutually exclusive outcomes of: (i) mortality before one year of age, (ii) survival free of major neurosensory disability, and (iii) survival with major neurosensory disability for six different scenarios where a liveborn infant was offered active care after birth (Appendix S1).

Data were imported from REDCap into Stata 18 (StataCorp, College Station, TX, USA) for analysis. The proportions who completed the survey (responded to all six scenarios) and the proportions of correct responses from those who were able to use the app correctly were determined. The true rates of mortality, and survival with and without major neurosensory disability for each of the six scenarios were subtracted from each participant's estimations for each combination, and the mean values compared with the null value of zero using linear regression with models fitted using generalised estimating equations to allow for the lack of independence of multiple responses from the same participant. Results were reported as mean differences, 95% confidence intervals (CIs) and *P*-values. For the participants who provided data for all scenarios, we compared those who were 100% accurate on all scenarios with those who were not on years of experience by independent *t*-test, and whether or not their primary practice was in a tertiary centre (including the PIPER emergency retrieval service;) or not by χ^2, from which odds ratios (ORs) and 95% CIs were obtained.

RESULTS

A total of 85 clinicians responded, but only 74 (87%) respondents provided data for at least one scenario, and 70 (82%) provided data for all scenarios. Of those who responded to the survey, the largest group were obstetricians, followed by neonatologists, midwives or nurses, paediatricians, and general practitioners (Table 1). Just under two-thirds (45; 64%) worked in a tertiary centre. Although the mean duration of working in perinatal care was 13 years, the level of experience was wide, ranging from two to 35 years.

Among the 70 who completed the survey, 47 (67%) were completely accurate for all scenarios. Accuracy for all individual components was 76% (321) for the 420 scenarios. Accuracy rates were similar for mortality (80%; 334/420), survival free of major disability (77%; 324/420) and survival with major disability (78%; 329/420). Overall, there was little evidence that the predicted estimates of mortality were substantially different from the true values (mean difference 0.7%; 95% CI −0.7, 2.1; *P* = 0.33) (Table 2). Similarly, overall there was little evidence that the predicted estimates of survival free of major disability were substantially different from the true values (mean difference − 0.7%; 95% CI −3.0, 1.7; *P* = 0.58). However, overall there was strong evidence that the predicted estimates of survival with major disability overall were overestimated compared with the true values (mean difference 4.9%; 95% CI 1.7, 8.0; *P* = 0.003). Although accuracy was high for all scenarios, where responses were inaccurate, the amount by which the response was different from zero was wide, with a range of almost 100% (Fig. 1). The inaccurate responses were symmetrical for mortality and survival without major disability, but positively skewed for survival with major disability (Fig. 1).

Within individual scenarios, the patterns were similar to those seen overall, with evidence for overestimates of survival with major disability for all scenarios, but little evidence for differences in mortality or survival free of major disability, with one exception. For the scenario with the best prognosis (Scenario C: 25 weeks, female, antenatal corticosteroids, inborn), there was evidence that not only was survival with major disability overestimated, so too was mortality, and survival free of major disability was underestimated (Table 2).

Participants who were 100% accurate compared with those who were not 100% accurate on all scenarios had similar years of experience (years, mean (SD): accurate 13.2 (8.7); not accurate 13.8 (8.8); mean difference − 0.6; 95% CI −5.1, 3.8; *P* = 0.78), but there was weak evidence that they were less likely to work in a tertiary centre (% (*n*/*N*): accurate 60% (27/45); not accurate 80% (20/25); OR 0.38; 95% CI 0.12, 1.18; *P* = 0.09). The sample sizes within the different professional disciplines and at different workplaces were too small to realistically compare estimates of the accuracy of the three mutually exclusive outcomes between subgroups.

DISCUSSION

Most perinatal clinicians who responded could correctly use NIC-PREDICT to estimate expected outcomes for infants born EP who are offered survival-focused care after birth, particularly for mortality and for survival free of major disability. However, it is concerning that clinicians still overestimated the expected rate of survival with major disability.

There was improvement in the accuracy of the prediction of mortality rates compared with our earlier surveys. For infants offered active care at 24 weeks' gestation in the earlier surveys, mortality was overestimated by 6.7% in the 2010 survey[10] and was even more overestimated by 14.7% in the 2020 survey.[11] For the two scenarios involving infants at 24 weeks in the current survey, mortality was not overestimated (mean difference − 0.5%; 95% CI −2.0, 0.9; *P* = 0.47). NIC-PREDICT has seemingly led to increased accuracy of prediction of mortality risk for infants born at 24 weeks' gestation.

Although the correct answers for survival with major disability were available from NIC-PREDICT, the fact that there was still a systematic overestimate of the rate of survival with major disability among those who responded is puzzling, perhaps reflecting a conscious or unconscious bias that the long-term quality of survival for children born EP is poor. However, compared with our

TABLE 1 Characteristics of respondents who provided data for all scenarios

Professional group and response rate within each group	Number in each group Total *N* = 70	% within group (*n*)
Midwives and nurses		
• Tertiary perinatal centre	13 (19%)	46% (6)
• Tertiary children's hospital		31% (4)
• PIPER		23% (3)
Obstetricians		
• Non-tertiary public hospital	26 (37%)	35% (9)
• Non-tertiary private hospital		11% (3)
• Tertiary perinatal centre		54% (14)
Paediatricians		
• Non-tertiary public hospital	12 (17%)	67% (8)
• Non-tertiary private hospital		17% (2)
• Tertiary children's hospital		8% (1)
• PIPER		8% (1)
Neonatologists		
• Non-tertiary hospital	17 (24%)	12% (2)
• Tertiary perinatal centre		47% (8)
• Tertiary children's hospital		23% (4)
• PIPER		18% (3)
General practitioners		
• Non-tertiary hospital	1(1.4%)	100% (1)
Not stated – tertiary centre	1 (1%)	
Type of health service		
• Non-tertiary public hospital		29% (20/70)
• Non-tertiary private hospital		7% (5/70)
• Tertiary centre		54% (38/70)
• PIPER		10% (7/70)
Years working in perinatal care		
Mean, (SD)	13.4 years (8.7)	
Range	(2–35)	

PIPER, Paediatric Infant Perinatal Emergency Retrieval, Victoria

2020 survey, in which major disability was overestimated by 35%, an overestimate of 4.9% was a vast improvement.

Participants who were 100% accurate compared with those who were not 100% accurate had similar years of experience but were less likely to work in a tertiary centre. Perhaps those working in tertiary care units were more reliant on their level of expertise than the data provided by NIC-PREDICT in completing the questionnaire, and consequently were not as accurate as they should have been. Where responses were inaccurate, the range of error was almost 100%, indicating there is more work required to improve accuracy overall.

Although we cannot calculate the response rate to this study, the uptake of NIC-PREDICT has been widespread, with the app being accessed 11 621 times in 2022 alone. We have also been approached by clinicians from other states of Australia and internationally, who are interested in validating the algorithm for EP infants in their state. Given the variation in regional practices in approach to care of EP infants both within Australia and internationally, and therefore variations in outcome,[15,16] we recommend tools developed to predict outcome should be based on local population-based outcome data to provide parents with realistic outcome predictions for their infant.

As the prognosis for infants offered survival-focused care following EP birth continues to improve[17,18] it is imperative that the outcome data in NIC-PREDICT are continually updated. We are currently updating the survival algorithm for NIC-PREDICT for EP infants born in 2018–2022 and will be updating the disability data when a longitudinal cohort of extremely preterm infants born in Victoria in 2016–17 are assessed at eight years of age in 2024/2025.

Study strengths and limitations

A strength of our study is the use of methods that are familiar to us and to those who we surveyed. This is now the third survey since 2010 targeting the same group of perinatal clinicians.

TABLE 2 Estimated vs actual outcomes, both overall, and for each scenario

Outcome	Estimated %	Actual %	Mean difference (95% CI) *P*-value
Overall			
Mortality	42.2%	41.5%	0.7% (−0.7, 2.1) 0.33
Survival free of major disability	45.0%	45.7%	−0.7% (−3.0, 1.7) 0.58
Survival with major disability	18.0%	13.2%	4.9% (1.7, 8.0) 0.003
Within each scenario			
Scenario A (24 weeks, female, antenatal corticosteroids, outborn)			
Mortality	36.9 (7.5)	37.0	−0.1% (−1.8, 1.7) 0.95
Survival free of major disability	51.5 (11.9)	52.0	−0.5% (−3.4, 2.3) 0.72
Survival with major disability	16.0 (13.2)	11.0	5.0% (1.8, 8.1) 0.002
Scenario B (23 weeks, male, antenatal corticosteroids, inborn)			
Mortality	45.8 (7.6)	44.0	1.8% (−0.05, 3.6) 0.056
Survival free of major disability	37.6 (10.5)	37.0	0.6% (−1.9, 3.1) 0.64
Survival with major disability	22.6 (11.2)	19.0	3.6% (0.9, 6.3) 0.009
Scenario C (25 weeks, female, antenatal corticosteroids, inborn)			
Mortality	16.9 (10.1)	14.0	2.9% (0.5, 5.3) 0.017
Survival free of major disability	69.8 (13.6)	74.0	−4.2% (−7.4, −0.9) 0.013
Survival with major disability	15.7 (11.7)	12.0	3.7% (0.9, 6.5) 0.01
Scenario D (24 weeks, male, no antenatal corticosteroids, outborn)			
Mortality	59.0 (9.2)	60.0	−1.0% (−3.2, 1.2) 0.36
Survival free of major disability	29.8 (11.9)	28.0	1.8% (−1.1, 4.6) 0.22
Survival with major disability	18.2 (17.5)	12.0	6.2% (2.0, 10.3) 0.004
Scenario E (23 weeks, female, no antenatal corticosteroids, inborn)			
Mortality	49.9 (8.8)	49.0	0.9% (−1.1, 3.0) 0.37
Survival free of major disability	40.2 (11.9)	41.0	−0.8% (−3.7, 2.0) 0.56
Survival with major disability	16.6 (16.5)	11.0	5.6% (1.6, 9.5) 0.006
Scenario F (25 weeks, male, no antenatal corticosteroids, outborn)			
Mortality	44.6 (9.8)	45.0	−0.4% (−2.7, 2.0) 0.76
Survival free of major disability	41.2 (11.5)	42.0	−0.8% (−3.6, 1.9) 0.54
Survival with major disability	19.1 (15.3)	14.0	5.1% (1.5, 8.8) 0.007

A major limitation of the current study is the small sample size of those who responded. That fewer people responded to the current survey than either of the two earlier surveys could reflect questionnaire fatigue. However, of those who did respond it seems that most could use NIC-PREDICT to derive accurate data about the three mutually exclusive outcomes confronting infants born EP. Another limitation of NIC-PREDICT at present is that there are no estimates of outcomes for infants born before 23 weeks of pregnancy. This occurred, in part, because there were no survivors at 22 weeks' gestation in the dataset used to develop NIC-PREDICT, which, for mortality, comprised births in the state of Victoria from 2009–2017.[19] We are incorporating outcomes for those born at 22 weeks into the current update of the app, particularly given the release of the Extremity Prematurity Guideline from Safer Care Victoria in December 2020, which stated the following: 'Consider active management following live birth (resuscitation, neonatal intensive care admission) from 22 weeks – but only in ideal circumstances, such as for babies born in a tertiary (Level 6) perinatal centre, and for babies free of adverse perinatal risk factors.'[14]

The next steps in translating NIC-PREDICT into clinical practice are to assess if the rates of being outborn (born outside a tertiary maternity hospital) have diminished, and if the proportions offered active care and their survival rates have risen, particularly for those born <24 weeks after NIC-PREDICT was released compared with just prior to its release. Given the undue pessimism of the past concerning both mortality rates and rates of survival free of major disability, it would be expected that providing more accurate data through NIC-PREDICT will reduce any pessimism being conveyed to families and result in more infants born EP being offered active care, including more being transferred in utero to tertiary maternity hospitals, more being offered active care after birth and more surviving.

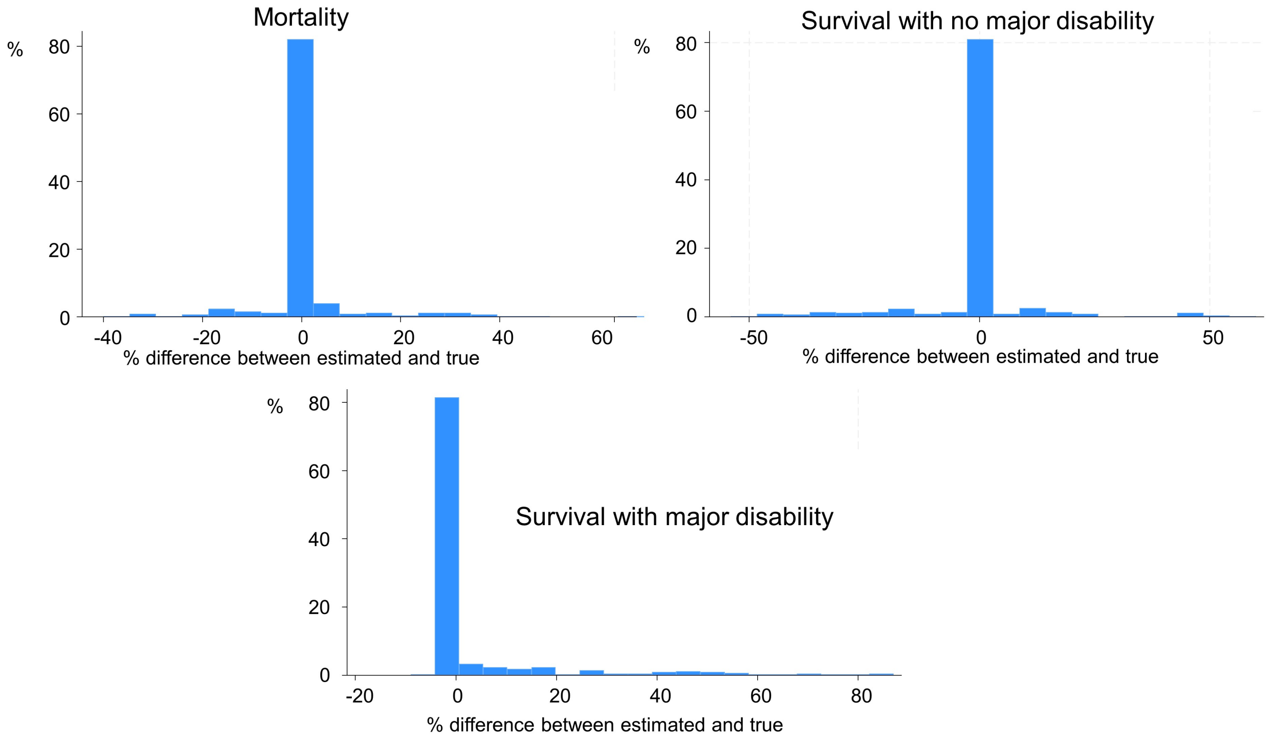

FIGURE 1 Histograms illustrating accuracy of responses for each outcome.

In conclusion, most perinatal clinicians who responded can correctly use NIC-PREDICT to estimate expected outcomes in infants born EP who are offered survival-focused care. However, undue pessimism about survival with major disability remains an ongoing concern. Although only released in late 2020, NIC-PREDICT will need to be updated periodically to ensure that it remains contemporaneous for predicting outcomes for our most immature infants, which, in turn, will ensure that families are provided with the most accurate data on the likely long-term outcomes for their babies.

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AUTHOR CONTRIBUTIONS

RAB designed the study, wrote the ethics, analysed the data, and wrote the draft manuscript. LWD supervised and contributed to the study design, statistical analysis, and edited the manuscript. JLC, MJS, SCK and LWD all edited the manuscript. Each author has reviewed the manuscript and approved submission of this version. The authors take full responsibility for the manuscript.

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REFERENCES

1. Morisaki N, Isayama T, Samura O *et al*. Socioeconomic inequity in survival for deliveries at 22-24 weeks of gestation. *Arch Dis Child Fetal Neonatal Ed* 2018; **103**(3): F202–F207. https://doi.org/10.1136/archdischild-2017-312635.
2. Ireland S, Ray R, Larkins S, Woodward L. Factors influencing the care provided for periviable babies in Australia: a narrative review. *Reprod Health* 2015; **12**: 108 https://doi.org/10.1186/s12978-015-0094-8.
3. Carlo WA, McDonald SA, Fanaroff AA *et al*. Association of antenatal corticosteroids with mortality and neurodevelopmental outcomes among infants born at 22 to 25 weeks gestation. *JAMA* 2011; **306**(21): 2348–2358. https://doi.org/10.1001/jama.2011.1752.
4. Doyle LW, Spittle AJ, Olsen JE *et al*. Translating antenatal magnesium sulphate neuroprotection for infants born <28 weeks' gestation into practice: a geographical cohort study. *Aust N Z J Obstet Gynaecol* 2021; **61**(4): 513–518. https://doi.org/10.1111/ajo.13301.
5. Chawla S, Wyckoff MH, Rysavy MA *et al*. Association of Antenatal Steroid Exposure at 21 to 22 weeks of gestation with neonatal

survival and survival without morbidities. *JAMA Netw Open* 2022; **5**(9): e2233331 https://doi.org/10.1001/jamanetworkopen.2022.33331.
6. Yeoh M, Rafferty S, Saw C *et al*. Fifteen-minute consultation: outcomes of the extremely preterm infant (<27 weeks): what to tell the parents. *Arch Dis Child Educ Pract Ed* 2023; **108**(3): 163–166. https://doi.org/10.1136/archdischild-2020-321178.
7. Geurtzen R, Van Heijst A, Hermens R *et al*. Preferred prenatal counselling at the limits of viability: A survey among Dutch perinatal professionals. *BMC Pregnancy Childbirth* 2018; **18**(1): 7 https://doi.org/10.1186/s12884-017-1644-6.
8. Wood K, Di Stefano LM, Mactier H *et al*. Individualised decision making: Interpretation of risk for extremely preterm infants—A survey of UK neonatal professionals. *Arch Dis Child Fetal Neonatal Ed* 2022; **107**(3): 281–288. https://doi.org/10.1136/archdischild-2021-322147.
9. Morse SB, Haywood JL, Goldenberg RL *et al*. Estimation of neonatal outcome and perinatal therapy use. *Pediatrics* 2000; **105**(5): 1046–1050. https://doi.org/10.1542/peds.105.5.1046.
10. Boland RA, Davis PG, Dawson JA, Doyle LW. What are we telling the parents of extremely preterm babies? *Aust N Z J Obstet Gynaecol* 2016; **56**(3): 274–281. https://doi.org/10.1111/ajo.12448.
11. Boland RA, Cheong JLY, Stewart MJ *et al*. Disparities between perceived and true outcomes of infants born at 23-25 weeks' gestation. *Aust N Z J Obstet Gynaecol* 2022; **62**(2): 255–262. https://doi.org/10.1111/ajo.13443.
12. Roberts G, Anderson PJ, De Luca C, Doyle LW. Changes in neurodevelopmental outcome at age eight in geographic cohorts of children born at 22-27 weeks' gestational age during the 1990s. *Arch Dis Child Fetal Neonatal Ed* 2010; **95**(2): F90–F94. https://doi.org/10.1136/adc.2009.165480.
13. Doyle LW, Roberts G, Anderson PJ. Outcomes at age 2 years of infants < 28 weeks' gestational age born in Victoria in 2005. *J Pediatr* 2010; **156**(1): 49–53. S0022-3476(09)00646-5 [pii] 10.1016/j.jpeds.2009.07.013.
14. Extreme Prematurity (State Govenment of Victoria) (2000). Available from https://www.safercare.vic.gov.au/best-practice-improvement/clinical-guidance/neonatal/extreme-prematurity
15. Draper ES, Zeitlin J, Fenton AC *et al*. Investigating the variations in survival rates for very preterm infants in 10 European regions: The MOSAIC birth cohort. *Arch Dis Child Fetal Neonatal Ed* 2009; **94**(3): F158–F163. https://doi.org/10.1136/adc.2008.141531.
16. Rysavy MA, Li L, Bell EF *et al*. Between-hospital variation in treatment and outcomes in extremely preterm infants. *N Engl J Med* 2015; **372**(19): 1801–1811. https://doi.org/10.1056/NEJMoa1410689.
17. Boland RA, Cheong JL, Doyle LW. Changes in long-term survival and neurodevelopmental disability in infants born extremely preterm in the post-surfactant era. *Semin Perinatol* 2021; **45**: 151479 https://doi.org/10.1016/j.semperi.2021.151479.
18. Cheong JL, Spittle AJ, Burnett AC *et al*. Have outcomes following extremely preterm birth improved over time? *Semin Fetal Neonatal Med* 2020; **25**(3): 101114 https://doi.org/10.1016/j.siny.2020.101114.
19. Boland RA, Cheong JLY, Stewart MJ, Doyle LW. Temporal changes in rates of active management and infant survival following live birth at 22–24 weeks' gestation in Victoria. *Aust N Z J Obstet Gynaecol* 2021; **61**(4): 528–535. https://doi.org/10.1111/ajo.13309.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1: REDCap survey instrument: Improving accuracy of outcome prediction in babies born extremely preterm.