Apgar score and the risk of cause-specific infant mortality: a population-based cohort study

Stamatina Iliodromiti, Daniel F Mackay, Gordon C S Smith, Jill P Pell, Scott M Nelson

Summary

Background The Apgar score has been used worldwide as an index of early neonatal condition for more than 60 years. With advances in health-care service provision, neonatal resuscitation, and infant care, its present relevance is unclear. The aim of the study was to establish the strength of the relation between Apgar score at 5 min and the risk of neonatal and infant mortality, subdivided by specific causes.

Methods We linked routine discharge and mortality data for all births in Scotland, UK between 1992 and 2010. We restricted our analyses to singleton livebirths, in women aged over 10 years, with a gestational age at delivery between 22 and 44 weeks, and excluded deaths due to congenital anomalies or isoimmunisation. We calculated the relative risks (RRs) of neonatal and infant death of neonates with low (0–3) and intermediate (4–6) Apgar scores at 5 min referent to neonates with normal Apgar score (7–10) using binomial log-linear modelling with adjustment for confounders. Analyses were stratified by gestational age at birth because it was a significant effect modifier. Missing covariate data were imputed.

Findings Complete data were available for 1029 207 eligible livebirths. Across all gestational strata, low Apgar score at 5 min was associated with an increased risk of neonatal and infant death. However, the strength of the association (adjusted RR, 95% CI referent to Apgar 7–10) was strongest at term (p<0·0001). A low Apgar (0–3) was associated with an adjusted RR of 359·4 (95% CI 277·3–465·9) for early neonatal death, 30·5 (18·0–51·6) for late neonatal death, and 50·2 (42·8–59·0) for infant death. We noted similar associations of a lower magnitude for intermediate Apgar (4–6). The strongest associations were for deaths attributed to anoxia and low Apgar (0–3) for term infants (RR 961·7, 95% CI 681·3–1357·5) and preterm infants (141·7, 90·1–222·8). No association between Apgar score at 5 min and the risk of sudden infant death syndrome was noted at any gestational age (RR 0·6, 95% CI 0·1–4·6 at term; 1·2, 0·3–4·8 at preterm).

Interpretation Low Apgar score at 5 min was strongly associated with the risk of neonatal and infant death. Our findings support its continued usefulness in contemporary practice.

Funding None.

Introduction

The Apgar score has been used worldwide as an index of health in the immediate neonatal period for more than 60 years.1 Its ability to assess the need for, and response to, resuscitation has led to it being incorporated into national guidelines and WHO policy:2,3 By virtue of its associations with short-term and long-term mortality, the Apgar score is also used as an early surrogate outcome for strategies designed to achieve the Millennium Development Goal of reducing child mortality.4

Assessment of the Apgar score at 5 min after birth in contemporary populations in which provision of neonatal intensive care is routinely available, has been scarce.5,6 Results from a population study of 235 165 births from 1983 to 1987 suggested an association between low Apgar score at 5 min and neonatal mortality.7 Similar associations were reported in a single centre study of 151 891 singletons from 1988 to 1998.7 A population study of US birth registry data from 1995 to 2004 also reported increased crude mortality rates in term and preterm infants with low Apgar scores at 5 min.8 Importantly, none of these studies adjusted for known risk factors for mortality including birthweight, social class, smoking status, or previous neonatal death. Furthermore, whether the deaths were potentially preventable was not reported.

In this study we analysed nationally collected data from Scotland where advanced resources for neonatal resuscitation are routinely available to characterise the neonatal, infant, and cause-specific mortality risk of newborn infants in relation to their Apgar score at 5 min. We established whether these associations persisted after adjustment for risk factors known to increase mortality rates in term and preterm infants, and after exclusion of deaths due to congenital anomalies.

Methods

Study population

We linked four Scotland-wide databases: the Scottish Morbidity Record 02 (SMR02); the National Records for Scotland (NRS); the Scottish Stillbirth and Infant Death Survey (SSBIDS); and the General Registrar for Scotland’s death certificate database. The SMR02 records information on all women discharged from Scottish maternity hospitals, including maternal and infant characteristics, clinical
management, and obstetric complications. The SMR02 is subjected to regular quality assurance exercises. The most recent compared a 4-4% sample of SMR02 returns (n=2531) with case records and showed that all of the data items used in our study were more than 90% complete and accurate. Gestational age has been confirmed by ultrasound in the first half of pregnancy in more than 95% of women in the UK since the early 1990s. The NRS registers all stillbirths and infant deaths and the SSBSIDS then obtains additional information from the SSBSIDS coordinator at the relevant hospital (who is an obstetrician, paediatrician, or midwife). The coordinator submits copies of the relevant case summaries, post-mortem reports, discharge letters, and perinatal mortality meeting reports and completes a questionnaire. The General Registrar for Scotland collates information from death certificates including the primary and secondary causes of death. The advisory committee of the Information Services Division (ISD) of the National Services Scotland gave approval for records’ access and linkage.

### Inclusion and exclusion criteria

We obtained SMR02 data for all infants delivered in Scotland between Jan 1, 1992, and Dec 1, 2010 inclusive, those equating to the most recent data available at the time of data extraction. Our analyses were restricted to singleton births in girls or women older than 10 years with a gestational age at delivery between 24 and 44 weeks inclusive. We excluded infant deaths due to iso-immunisation or congenital anomalies.

### Definitions

We defined death caused by congenital anomaly as any structural or genetic defect incompatible with life or potentially treatable but causing death.

Postcode of residence is recorded on the SMR02 record and is used to allocate individuals to an area-based socioeconomic decile of the general population using the 2004 Scottish Index of Multiple Deprivation (SIMD). The index is derived from 31 area markers of deprivation measures across the domains of health, education, housing, present income, employment access, and crime, which are applied to every postcode data zone. 6505 data zones are located across Scotland with a mean population of 750.

We classified Apgar scores at 5 min of age into three ordinal groups: low (Apgar 0–3), intermediate (Apgar 4–6), and normal (Apgar 7–10). The primary outcomes studied were: early neonatal deaths (from birth to 7 days of life), late neonatal deaths (from day 7 to day 28), overall neonatal deaths (up to 4 weeks), and overall infant deaths (up to 1 year). The secondary outcome was cause-specific mortality. We defined sudden infant death syndrome as infant deaths for which the primary cause was recorded as an International Classification of Diseases 10 (ICD-10) code of R95 or an ICD-9 code of 798.0. We coded neonatal causes using a modification of the Wigglesworth paediatric classification, including anoxia and infection. The definition of anoxia was broad and included hypoxia, acidosis, and asphyxia. In preterm neonates, we included hyaline membrane disease as an additional cause of death. By contrast, lung immaturity is restricted by definition to neonates born before 27 weeks’ gestation and was not deemed a secondary outcome.

### Articles

For more on NRS see http://www.nrscotland.gov.uk
For more on SSBSIDS see http://www.isdscotland.org/Health-Topics/Maternity-and-Births/Stillbirth-and-Infant-Deaths/SPIMMR-Background-Information.pdf

Figure 1: Definition of eligible cohort and analysis sample
ICH=intracranial haemorrhage. SIDS=sudden infant death syndrome. *Some records could have several exclusions.

<table>
<thead>
<tr>
<th>Maternal age, years (IQR)</th>
<th>Normal Apgar score (n=1033353)</th>
<th>Intermediate Apgar score (n=10202)</th>
<th>Low Apgar score (n=5642)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age, years (IQR)</td>
<td>29 (24–33)</td>
<td>28 (23–32)</td>
<td>28 (24–32)</td>
</tr>
<tr>
<td>Maternal height, cm (IQR)</td>
<td>163 (158–167)</td>
<td>162 (157–166)</td>
<td>162 (157–166)</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>459 696 (45.6%)</td>
<td>5604 (55.2%)</td>
<td>2491 (44.3%)</td>
</tr>
<tr>
<td>1</td>
<td>347 324 (34.4%)</td>
<td>2770 (27.3%)</td>
<td>1789 (31.8%)</td>
</tr>
<tr>
<td>≥2</td>
<td>203 821 (20.0%)</td>
<td>1778 (17.5%)</td>
<td>3344 (23.9%)</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smokers</td>
<td>250 276 (27.3%)</td>
<td>2825 (31.1%)</td>
<td>1689 (34.6%)</td>
</tr>
<tr>
<td>Ex-smokers</td>
<td>86 347 (9.4%)</td>
<td>879 (9.7%)</td>
<td>452 (9.3%)</td>
</tr>
<tr>
<td>Never smoker</td>
<td>579 759 (63.3%)</td>
<td>5385 (59.3%)</td>
<td>273 (55.1%)</td>
</tr>
</tbody>
</table>

(Table 1 continues on next page)
Confounders and risk factors
We adjusted the risk of death for maternal age, parity, socioeconomic deprivation, year of delivery, marital status, smoking status, history of neonatal death, mode of delivery (vaginal or abdominal), and timing of delivery (elective included all induced labours and programmed caesarean sections, unplanned included all spontaneous onset labours and emergency caesarean sections), sex of the baby, and birthweight (classified according to sex, gestation-specific centiles: 1st–10th centile, 11th–90th centile, and >90th centile). The 11th–90th centile was treated as the referent category for the regression models and the 1st–10th centile referred to the small-for-gestation category. We examined gestation of delivery in stratified analyses in accordance with recent recommendations: 24–31 weeks, 32–33 weeks, 34–36 weeks, 37–38 weeks, 39–40 weeks, 41–41 weeks, 42 weeks or greater.12

Statistical analyses
We used median and IQRs for continuous variables and Kruskal–Wallis test for descriptive statistics. We used χ² tests to compare categorical variables between groups. We modelled relative risks (RRs) of the outcomes with a binomial log-linear regression model before and after adjustment for confounders. Missing values for confounders were imputed (n=5) and the regression models were used with imputed values replacing missing values. We assessed the significance of interaction terms using the likelihood-ratio test. We deemed p values lower than 0.05 to be significant. We did a sensitivity analysis to examine whether the associations between Apgar scores and mortality in the dataset with the complete set of covariates differed from those in the imputed dataset. Additionally, we did a sensitivity analysis to test whether the associations differed across epochs of year of delivery (four epochs: 1992–96, 1997–2000, 2001–05, and 2006–10). All analyses were done with Stata (version 12).

Results
Between Jan 1, 1992, and Dec 31, 2010, 1062 390 deliveries were recorded in Scotland. Of these deliveries, we excluded 33 183 (figure 1). Therefore, the study group consisted of the remaining 1029 207 deliveries.

Among these deliveries, 1395 (0.1%) neonatal deaths were recorded, of which 967 (0.1%) were early neonatal deaths and 428 (<0.1%) were late neonatal deaths (figure 1). Overall, 2307 (0.2%) infant deaths were recorded, 1050 (45%) were born at term (≥37 weeks) and 1257 (54.5%) of total infant deaths were born preterm (figure 1).

Most neonates (1013 363, 98.5%) had a normal Apgar score at 5 min (table 1). Women who delivered infants with a low Apgar at 5 min were more likely to be young, smokers, multiparous, and have an obstetric history of neonatal death than women who delivered neonates with a normal Apgar at 5 min. A low Apgar score at 5 min was more frequent in infants delivered preterm or by caesarean section than those delivered at term or vaginally.

### Table 1: Maternal characteristics, delivery details, and outcomes in relation to Apgar scores at 5 min of life

<table>
<thead>
<tr>
<th>Outcome category (n=1,013,363)</th>
<th>Normal Apgar score (n=1,013,363)</th>
<th>Intermediate Apgar score (n=10,202)</th>
<th>Low Apgar score (n=5,642)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation at delivery, weeks (IQR)</td>
<td>40 (39–41)</td>
<td>39 (37–40)</td>
<td>39 (36–40)</td>
</tr>
<tr>
<td>Mode of delivery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cephalic SVD</td>
<td>679,777 (69%)</td>
<td>5224 (52%)</td>
<td>3455 (58%)</td>
</tr>
<tr>
<td>Non-cephalic SVD</td>
<td>2767 (3%)</td>
<td>228 (2%)</td>
<td>207 (3%)</td>
</tr>
<tr>
<td>Instrumental delivery</td>
<td>90,410 (9%)</td>
<td>866 (8%)</td>
<td>378 (6%)</td>
</tr>
<tr>
<td>Elective caesarean section</td>
<td>80,531 (8%)</td>
<td>377 (3%)</td>
<td>249 (4%)</td>
</tr>
<tr>
<td>Emergency caesarean section</td>
<td>126,611 (12%)</td>
<td>3192 (32%)</td>
<td>1471 (26%)</td>
</tr>
<tr>
<td>Birthweight, g (IQR)</td>
<td>3260 (2800–3760)</td>
<td>3210 (2660–3650)</td>
<td>3210 (3200–3850)</td>
</tr>
<tr>
<td>Preterm</td>
<td>54,993 (54%)</td>
<td>2213 (21%)</td>
<td>1576 (27%)</td>
</tr>
<tr>
<td>Infant sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>495,281 (48%)</td>
<td>4424 (43%)</td>
<td>2694 (47%)</td>
</tr>
<tr>
<td>Male</td>
<td>518,040 (51%)</td>
<td>5775 (56%)</td>
<td>2948 (52%)</td>
</tr>
</tbody>
</table>

Data are n (%). Mutteral age, ≥10 years; maternal height, 195 792 (99%); parity, 4599 (0.9%); smoking status, 98 858 (9.6%); Scottish index of Multiple Deprivation, 4125 (0.4%); marital status, 245,510 (23.9%); previous neonatal deaths, 172 821 (16.8%); previous stillbirths, 172 775 (16.8%); previous miscarriage, 274 (<0.1%); previous abortion, 263 (0.1%); mode of delivery, 33 614 (3.3%); gestational age, 0 (<0.1%); sex, 45 (<0.1%); birthweight, 397 (<0.1%). SVD=spontaneous vaginal delivery. Normal Apgar score=7–10; intermediate Apgar score=4–6; low Apgar score=0–3.
The crude rate of neonatal and infant mortality decreased greatly and progressively with advancing gestational age (appendix) and with increased Apgar score at 5 min. However, we noted a significant interaction between gestational age and Apgar score category at 5 min (p<0.001), hence, subsequent analyses...
were stratified by gestational age. On the contrary, the interaction of Apgar score category at 5 min with birthweight centile was not significant (p=0·36), nor the interaction of Apgar score at 5 min with epochs of year of delivery (p=0·26). The RR of infant death associated with low Apgar score at 5 min increased progressively with advancing gestational age (figure 2, appendix). The RR of neonatal and infant mortality associated with a low Apgar score at 5 min peaked at 41–41+⁶ weeks, and subsequently decreased, although remaining highly significant. The patterns of absolute risk and RR of death were not materially affected when the analysis was restricted to complete cases (appendix). Appendix shows the adjusted RR for neonatal and infant mortality of other risk factors complimentary to low and intermediate Apgar scores.

Table 2 and appendix show the absolute infant mortality rates and the cause-specific mortality rates for term and preterm infants stratified by Apgar scoring at 5 min. A low Apgar score (0–3) was associated with an adjusted RR of 20·50 (16·87–24·68) for neonatal death, 220·16 (161·03–293·49) for early neonatal death, and 363·78 (266·56–483·76) for late neonatal death, and 50·2 (42·8–59·0) for infant death (appendix). We noted similar associations of a lower magnitude for intermediate Apgar (4–6). In term infants, the association between low Apgar and the risk of death was strongest for deaths due to anoxia (RR 961·7, 95% CI 681·3–1357·5). However, low Apgar at 5 min was also associated with death attributed to infection (RR 49·3, 95% CI 24·1–100·9), although the association was clearly weaker than that for anoxia. Among preterm infants, there was a similar pattern of stronger associations with death attributed to anoxia (RR 141·7, 95% CI 90·1–222·8) than with infection (13·0, 9·1–18·7). Additionally, there was an association between low Apgar at 5 min and the risk of death attributed to hyaline membrane disease. In both term (RR 0·6, 95% CI 0·1–4·6) and preterm (1·2, 0·3–4·8) infants mortality attributable to sudden infant death syndrome was unrelated to the Apgar score at 5 min. Preterm infants were more than three times likely to die from sudden infant death syndrome than term neonates independent of Apgar score at 5 min (ie, 14 infant deaths per 10 000 liveborn among preterm neonates with normal Apgar score at 5 min compared with four infant deaths per 10 000 liveborn among term neonates with normal Apgar score; table 2).

### Discussion

The Apgar score was first described more than 60 years ago. Despite huge changes in paediatric care and massive falls in the risk of infant death in the intervening period, we showed that the Apgar score at 5 min was still extremely strongly associated with the risk of neonatal and infant death in Scotland between 1992 and 2010. The associations with neonatal and infant mortality were present at both term and preterm gestations and robust to adjustment for a wide range of confounders. We showed that a low Apgar score at 5 min was strongly associated with neonatal and infant mortality attributable to anoxia or infection, with an additional association with hyaline membrane disease in preterm infants. However, the associations were cause specific. For example, there was no significant association between Apgar score at 5 min and the risk of sudden infant death syndrome, the leading single cause of post-neonatal infant death.

Outcomes in neonates delivered at 37 completed weeks and beyond are increasingly recognised to vary substantially, despite all neonates being classed as term. Therefore, we examined gestation cutpoints for stratification in accordance with recent recommendations. Previous studies stratified the risk of neonatal mortality in relation to low Apgar score at 5 min by birthweight rather than by gestation, despite birthweight being a function of gestational age and intrauterine growth. Our findings showed that gestational age rather than birthweight is an effect modifier of this relation. In premature infants, a low Apgar score might show intrinsic physiological immaturity
Panel: Research in context

Systematic review

We searched PubMed and Medline for reports published until February, 2014. Search terms for Apgar score (keyword: “Apgar*”) and infant mortality (keywords: “neonatal death”, “neonatal mortality”, “infant death”, “infant mortality”, “neonate”, and “infant”) were combined. The reference lists of the selected papers were hand-searched for other potentially relevant papers. We have cited all the relevant reports in the main text but we were mainly interested in studies relevant to our research question and referring to contemporary populations.2,9

Interpretation

The Apgar score at 5 min of life is an aggregate score of five readily identifiable neonatal characteristics: skin colour, heart rate, respiratory effort, muscle tone, and reflexes. Every category is assigned a score of 0, 1, or 2 depending on the observed condition. Despite advances in neonatal intensive care and routine provision of neonatal resuscitation, we confirm that 60 years after its introduction the Apgar score at 5 min is still predictive of neonatal and infant mortality. In accordance with national guidelines we categorised Apgar score in three categories (low, intermediate, and normal).2 We confirmed that infants with low and intermediate Apgar scores have a substantially increased risk of death within the first year of life and for the first time show that these associations are independent of other confounders and risk factors, and are particularly strong for term infants. Our novel cause-specific analyses show that the strongest associations were noted for deaths attributed to anoxia. Our study supports the ongoing clinical usefulness of Apgar scores in contemporary populations.

We declare no competing interests.

References

and inadequate capacity for response rather than abnormal autonomic, cardiovascular, and respiratory function in term infants.10,11

Gestational age at birth has consistently been shown to exhibit an inverse association with neonatal and infant mortality.12 The net effect of a low Apgar score at 5 min on the RR of both neonatal and infant mortality is thereby smaller for premature infants than observed at term. Although the Apgar score is associated with mortality at all gestations,7–11 the magnitude of the effect changes across the distribution of gestational ages because the background mortality risk of each gestational group varies. Hence, a normal score in preterm infants, unlike full-term infants, does not necessarily predict a good outcome.16

To our knowledge, this is the first study linking the effect of a low Apgar score at 5 min with specific causes of infant mortality (panel). At both term and preterm gestations, infants with a low Apgar score at 5 min were more likely to die from a cause attributable to anoxia than from other causes. Fetal hypoxia and acidosis, as detected by cord blood gas, are frequently associated with a reduction in the Apgar score.22 Similarly, maternal and fetal infections have been associated with low Apgar scores.22–24 Although a nested case-control study of 148 cases reported an inverse trend with Apgar score at 5 min and risk of sudden infant death syndrome,17 we did not see this trend; our larger sample size could be the reason, since our findings are consistent with two larger case-control studies.20,22

Our study included more than one million deliveries. We included all eligible deliveries in Scotland over a 19 year period, thereby avoiding selection bias and permitting extrapolation to other populations with similar baseline and ethnic characteristics. We linked four national datasets to maximise data completeness. The routine data sources are subject to quality assurance checks and perform well in terms of completeness and accuracy. The detail provided by these datasets allowed us to examine a range of different outcomes and adjust for a series of potential confounders and consider effect modifiers. We used robust methods to calculate the RR of the outcome for low and intermediate Apgar scores at 5 min compared with neonates with a normal Apgar score with and without adjustment for covariates.21 We acknowledge that our analyses had some limitations. Apgar score at 5 min is not subject to quality control measures but represents routine clinical practice.22 The individual components of the Apgar score at 5 min were not available to examine, but our findings add weight to the continuation of the Apgar score at 5 min in its present form. We did not have data on the Apgar score at 1 min, but evidence shows that the Apgar score at 5 min has greater predictive performance than the Apgar score at 1 min.20 We assumed that the population remained stable without infants selectively leaving Scotland and thereby introducing systematic error and that the complete dataset for the multivariable models were representative of the population. The fact that the effect size in the imputed models is not substantially attenuated in comparison with complete cases supports this assumption.

The Apgar score was developed to provide an early assessment of neonatal condition and stratify care when health-care resources and effective interventions were scarce. Our findings show that 60 years after its introduction it continues to be prognostic for neonatal and infant mortality in contemporary developed populations.

Contributors
SI searched the scientific literature, did the statistical analysis, participated in data interpretation, and drafted the report. DFM contributed to the statistical analysis and data interpretation. JPP collected the data and contributed to data interpretation. GCSS contributed to the statistical analysis and data interpretation. SMN conceived the study, contributed to the statistical analysis, data interpretation, and drafted the report. All authors contributed to preparation of the report and approved the final version.

Declaration of interests
We declare no competing interests.
Comment

Neonatal and infant death: the Apgar score reassessed

Apgar scores are used to convey information about newborn infants’ transition to an extrauterine environment. In The Lancet, Stamatina Iliodromiti and colleagues1 present a well-executed study to determine if previously recognised associations between Apgar scores and neonatal and infant mortality persist in a recent cohort. In 1953, Virginia Apgar published what was later named the Apgar score to assess newborn infants in the first minutes after birth.2 The reason was the poor quality and lack of precise data about resuscitation of newborn infants, despite other scores such as breathing time, crying time, or severity of respiratory depression. The goal was a simple classification to easily assess obstetric practice, maternal analgesia, and the effectiveness of newborn resuscitation. Variables scored were to be readily measured without interference in the care of the newborn baby. Assignment of the score at 1 min and 5 min was based on feasibility and usefulness. This simple score has had an enormous effect on neonatal resuscitation. Apgar scores have achieved the original goal of providing systematic, rapid assessment of infants after birth, and have facilitated a shared mental model of the newborn’s condition among personnel in the delivery room and subsequently in the nursery.

Early studies using the Apgar score to assess obstetric practice showed an inverse relation between neonatal mortality and Apgar scores at 1 min in 15 348 infants born from 1952 to 1956.3 Although not the original intent of the score, subsequent work extended the association, noting increased neonatal mortality with lower Apgar scores at 5 min in 17 534 infants irrespective of birthweight.4 Despite the information provided by Apgar scores, they are frequently criticised for ambiguities and uncertainties.5 Scoring is subjective and inter-rater reliability has been a concern. The components of the score are not weighted but Apgar commented that weighting would negate the simplicity.1 No accepted guidelines exist for assigning Apgar scores in infants who are intubated.4 Initiation of infant stabilisation begins immediately after birth and does not hinge on Apgar scores.7

When the Apgar score was developed, obstetric and anaesthesia practices were vastly different, resuscitation of newborn infants was limited to simple interventions without a team approach, and neonatal intensive care was primordial. In view of the limitations, are Apgar scores relevant to present practice? To address such concerns, Iliodromiti and colleagues1 used data from more than 1 million singleton births between 1992 and 2010 to confirm that very low Apgar scores at 5 min (0–3) are strongly associated with the risk of neonatal and infant death (adjusted relative risk [RR] 359·4, 95% CI 277·3–465·9 vs Apgar 7–10 for early neonatal death; 30·5, 18·0–51·6 for late neonatal death; and 50·2, 42·8–59·0 for infant death).1

The authors drew on four databases to capture mortality and important maternal and infant characteristics for women discharged from all Scottish maternity hospitals. The results confirm and extend observations from other investigators.8–10 The report has many strengths, including use of robust data sources with quality checks, analyses stratified for gestational age (a strong correlate of mortality), and adjustment of results for covariates known to increase mortality rates in term and preterm infants. The data spanned almost two decades and the association between very low Apgar score at 5 min (0–3) and mortality did not differ over this time interval. The RR of neonatal or infant mortality with Apgar scores of 0–3 at 5 min (relative to Apgar scores of 7–10) was progressively greater with advancing gestational age. This in part shows the many morbidities contributing to mortality of prematurity that are often independent of Apgar scores. Similar but
less prominent associations were noted for Apgar scores of 4–6 at 5 min.

This report extends earlier work by examining cause-specific mortality risk in relation to Apgar scores at 5 min. The data were restricted in that causes were assigned only to term and preterm infants who survived beyond the neonatal period, and causes were unrecorded in 27.6% of deaths in infants born at term and 18.9% of those born preterm. Assignment of cause of death can be challenging, and granular detail about criteria for each cause is beyond the report’s scope. However, in term infants the association between Apgar scores of 0–3 and mortality was strongest for deaths attributed to anoxia. Although there are limitations to these data, an important area of research is whether neuroprotective therapies alter the relation between very low Apgar scores and mortality. Since 2005, many randomised trials of therapeutic hypothermia among infants at 36 weeks’ gestation or more with encephalopathy show less death or disability at 18 months of age with targeted temperature reduction. Childhood follow-up of infants (aged 6–7 years) from these trials is encouraging. Therapeutic hypothermia has been widely used and is considered usual care for infants meeting criteria of those enrolled in the trials.

Apgar scores have been misinterpreted in the past. Low Apgar scores have been assumed to be an indication of asphyxia even though there are many other causes of low Apgar scores, some of which are more common than asphyxia. Low Apgar scores are one piece in a complex puzzle to determine if newborn encephalopathy is attributable to asphyxia or some other cause. Furthermore, Apgar scores of 0–3 are rare events and the high RR for mortality needs to be used cautiously by clinicians in view of the low prevalence. However, such misinterpretation does not detract from the original purpose of the Apgar score, in addition to serving as a rapid marker for mortality risk before other data and assessments become available.

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5 Bharti B, Bharti S. A review of the Apgar score indicated that contextualization was required within the contemporary perinatal and neonatal care framework in different settings. J Clin Epidemiol 2005; 58: 121–29.