Child mortality in England during the COVID-19 pandemic

ABSTRACT

Objectives Using the National Child Mortality Database (NCMD), this work aims to investigate and quantify the characteristics of children dying of COVID-19, and to identify any changes in rate of childhood mortality during the pandemic.

Design We compared the characteristics of the children who died in 2020, split by SARS-CoV-2 status. A negative binomial regression model was used to compare mortality rates in lockdown (23 March–28 June), with those children who died in the preceding period (6 January–22 March), as well as a comparable period in 2019.

Setting England.

Participants Children (0–17 years).

Main outcome measures Characteristics and number of the children who died in 2020, split by SARS-CoV-2 status.

Results 1550 deaths of children between 6th of January and 28 June 2020 were notified to the NCMD; 437 of the deaths were linked to SARS-CoV-2 virology records, 25 (5.7%) had a positive PCR result. PCR-positive children were less likely to be white (37.5% vs 69.4%, p<0.003) and were older (12.2 vs 0.7 years, p<0.0006) compared with child deaths without evidence of the virus. All-cause mortality rates were similar during lockdown compared with both the period before lockdown in 2020 (rate ratio (RR) 0.93 (0.84 to 1.02)) and a similar period in 2019 (RR 1.02 (0.92 to 1.13)).

Conclusions There is little to suggest that there has been excess mortality during the period of lockdown. The apparent higher frequency of SARS-CoV-2-positive tests among children from black, Asian and minority ethnic groups is consistent with findings in adults. Ongoing surveillance is essential as the pandemic continues.

BACKGROUND

The COVID-19 pandemic is one of the biggest global challenges faced in our lifetime. In England, by 30 June, over 244,336 people had tested positive for COVID-19, and over 39,962 COVID-19-related deaths had been identified. While publications report little evidence for a significant excess mortality in children in the initial stages of the lockdown, there remain concerns of a hidden impact on the health of newborns, infants and children, with reports of adverse pregnancy outcomes, dramatic reductions in emergency hospital contacts, delayed presentation of serious illness, and increases in child maltreatment, malnutrition, and mental health problems.

Despite the unprecedented research efforts arising from the pandemic, few data have been published on the overall direct and indirect disease impact on child mortality. Standard national mortality registration does not have complete ascertainment in real time, meaning that the key question of ‘excess mortality’ will be difficult to assess for some time to come. To compound this, much of the current literature is based on case series or inpatient data. Initial data suggested that SARS-CoV-2 infection causes a similar disease in children to that seen in adults, but as the pandemic has progressed, novel presentations of hyperinflammatory states, abdominal symptoms and neurological pathology have been described. In addition, while we are aware of specific underlying disease states which appear to put adults at greater risk of severe disease, the relationship of COVID-19 disease and common chronic diseases of childhood, such as asthma, is unclear. SARS-CoV-2 may also have direct effects on the risk of perinatal events, although the exact impact is not known. Increased rates of preterm birth and perinatal asphyxia have been reported by some, while others report lower

What is already known on this topic?

Childhood SARS-CoV-2 disease may present in a variable way, often without clear respiratory symptoms, and so in many cases ascertainment is difficult.

What this study adds?

Child mortality was lower in 2020 than in 2019 with little to suggest that there has been an excess mortality among children during the period of lockdown.

Children who died and had a positive result for SARS-CoV-2 were more likely to be older and from ethnic minority groups.

We found little to suggest an over-representation of children with underlying health conditions.

rates; as well as recent reports of possible increases in stillbirth rates. Rapid population-based analyses during a pandemic are therefore essential to provide unbiased information on incidence and outcomes. The National Child Mortality Database (NCMD) was established in 2019, with the core aim to study and analyse the patterns, causes and associated risk factors of child mortality in England. Notification is required by statute within 48 hours.

Aims

The two primary aims of these analyses are to:
1. Identify the number and characteristics of children dying of COVID-19 in England during the first wave of the pandemic.
2. Identify changes in rate of overall childhood mortality during the lockdown period, compared with the pre-lockdown period in 2020, and a comparable (pre-pandemic) period in 2019.

Methodology

The NCMD commenced data collection on 1 April 2019 and collects data from all 58 Child Death Overview Panels (CDOPs) across England. There is a legal responsibility for CDOPs to notify NCMD of every death of anyone before their 18th birthday, including cases referred to the coroner for further investigation. From 1 March 2020, linkage with virology PCR results was performed with Public Health England (PHE) for the retrospective and prospective surveillance of COVID-19 child mortality in England and, for practical and workload reasons at the time, was limited to deaths where COVID-19 was a possible cause (i.e., not trauma or suicide deaths). In April 2020, the Joint Agency Response to child deaths during the COVID-19 pandemic protocol was amended to include postmortem viral swabs from all children dying suddenly and unexpectedly from no immediately identifiable cause (sudden unexpected death in infancy or childhood, SUDIC).

Coding of notifications

All deaths reported to the NCMD were coded by four independent coders (three paediatricians and one NCMD manager with CDOP expertise) to identify the most likely category of the cause of death, using a classification system based on that used by the child death review process since 2008. All coders reviewed the deaths blind to each other and recorded if the death was likely to be due to malignancy, preterm birth, intrapartum events, infection, trauma, substance misuse, suicide, an underlying medical condition, or if the event should be considered a SUDIC; or that there was insufficient information provided (see online supplemental appendix). To identify the most important factor contributing to the death, the most common category identified by the four coders was used as the most likely category. Where more than one category was identified, the category highest in likelihood was considered ‘high’ or ‘moderate’. Intrapartum deaths: electronic (BadgerNet) discharge summaries for all babies who had died in a neonatal intensive care unit were obtained. Where there remained disagreement about the likely cause of death, cases were recoded by one independent neonatologist blind to the date of death.

Table 1 Characteristics of all deaths between 6 January and 28 June 2020 split by COVID-19 status

<table>
<thead>
<tr>
<th>Measure</th>
<th>Number with data</th>
<th>SARS-CoV-2 negative deaths (n=412)</th>
<th>SARS-CoV-2 positive deaths (n=25)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age of death in years (IQR)</td>
<td>437</td>
<td>0.7 (0.1–6.0)</td>
<td>12.2 (0.6–15.2)</td>
<td>0.0006</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>432</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>344</td>
<td></td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other*</td>
<td>429</td>
<td>3 (2–6)</td>
<td>5 (2–7)</td>
<td>0.361</td>
</tr>
<tr>
<td>Deprivation measure (1–10)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td>437</td>
<td></td>
<td></td>
<td>0.097</td>
</tr>
<tr>
<td>London (all London boroughs)</td>
<td></td>
<td>63 (15.3%)</td>
<td>7 (28.0%)</td>
<td></td>
</tr>
<tr>
<td>Elsewhere</td>
<td></td>
<td>349 (84.7%)</td>
<td>18 (72.0%)</td>
<td>&gt;0.999</td>
</tr>
<tr>
<td>Place of death</td>
<td>431</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td></td>
<td>300 (73.7%)</td>
<td>18 (75.0%)</td>
<td></td>
</tr>
<tr>
<td>Elsewhere</td>
<td></td>
<td>107 (26.3%)</td>
<td>6 (25.0%)</td>
<td></td>
</tr>
<tr>
<td>Contributing underlying medical condition</td>
<td>437</td>
<td>124 (30.1%)</td>
<td>9 (36.0%)</td>
<td>0.511</td>
</tr>
</tbody>
</table>

Numbers are n (%) or median (IQR) as appropriate. Comparisons were made using Fisher’s exact test or Mann-Whitney U test as appropriate.

Statistical analysis

The analysis is based on deaths on, or before 28 June 2020. To ensure adequate time for notification, coding and clarification, data were downloaded and finalised 19 days later, on 17 July 2020. To investigate the profile of children dying with evidence of SARS-CoV-2, we compared the characteristics of the children
with known SARS-CoV-2 PCR testing; split by those with a positive or negative result. Comparisons were made using Fisher’s exact test for categorical data and Mann-Whitney U test for age and the IMD deprivation category.

Initially, we quantified the number of deaths that were reported to the NCMD and graphed the output (smoothing using the arithmetic means up to 7 days either side of point estimate). UK-wide restrictions to reduce the impact of the pandemic started on 23 March 2020. To investigate the characteristics of the deaths during the lockdown period (as infection rates rose, but also with widespread changes to social distancing, healthcare and education), we compared the sociodemographic characteristics of the children who died during lockdown, with those children who died in the period immediately before (23 March–28 June 2020 compared with 6 January–22 March 2020). In a second comparison, to adjust for seasonal changes, we then compared deaths during a slightly different period of the lockdown (30 March–28 June 2020) with a comparable period in pre-pandemic 2019 (1 April–30 June 2019) as we did not have data before the start of NCMD in 2019. Data were collapsed to provide frequency counts of events per day. The incidence of events during lockdown was compared with the rate in 2020 before lockdown using a negative binomial regression model to derive a rate ratio (RR) (and 95% CI) for the comparison.

![Figure 1](https://example.com/)  
**Figure 1** Mean number of deaths per day (15 days smoother average) split by time period. *Lockdown started 23 March 2020. 2019 comparison data from 1 April 2019 onwards.

### Table 2  
Characteristics of deaths in the lockdown period, compared with before lockdown and a comparable period in 2019

<table>
<thead>
<tr>
<th>Measure</th>
<th>During lockdown versus before lockdown</th>
<th>During lockdown versus 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number with data</td>
<td>Before lockdown (77 days) (n=711)</td>
</tr>
<tr>
<td>Time period</td>
<td>1550</td>
<td>0.2 (0.0–4.8)</td>
</tr>
<tr>
<td>Median age of death in years (IQR)</td>
<td>1521</td>
<td>417 (59.7%)</td>
</tr>
<tr>
<td>Sex</td>
<td>1177</td>
<td>314 (62.1%)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>1523</td>
<td>4 (2–7)</td>
</tr>
<tr>
<td>Other*</td>
<td>590 (83.0%)</td>
<td>693 (82.6%)</td>
</tr>
</tbody>
</table>

Numbers are n (%) or median (IQR) as appropriate.

Comparisons were made using Fisher’s exact test or Wilcoxon–Mann–Whitney test as appropriate.

* Asian or Asian British, black or black British, mixed or other.
their death (birth–27 days, 28 days–1 year, 1–4 years, 5–9 years, 10–14 years, 15–17 years).

**Sensitivity analyses**
Policy and guidance changed during the lockdown period with two distinct periods: before, and, on or after, 17 May 2020, when lockdown restrictions were eased. For the pre-lockdown comparison, the regression model was repeated, estimating the RR for the two periods of lockdown compared with deaths in the pre-lockdown period. For the comparison with lockdown versus 2019 pre-pandemic, the regression model was repeated allowing any association between year and the outcome to be modified by the period of lockdown; and separate RRs derived for the two periods. Models were compared with the main analysis to test (using the likelihood ratio test) if there was evidence that they fitted the data more precisely.

As exploratory analyses, the main analysis was repeated for the children who died in each provisional category of death (above) to give an indication of profile of causes of child mortality during lockdown.

Data were compared with provisional ONS data to ascertain data coverage. ONS mortality statistics are based on information recorded when deaths are certified and registered; and while most deaths are registered within 5 days, there are circumstances when there may be a substantial delay in issuing a Medical Certificate of Cause of Death, such as deaths reported to a coroner. The total number of child deaths registered by ONS from 11 January to 26 June 2020 for England, by age groups and week of death, was compared with NCMD data for the same period. Due to the fast-changing COVID-19 pandemic in England, prior to publication, the analysis was repeated with the most recent total deaths. In this analysis, using the same methodology as above, we compared the number of deaths reported to the NCMD between 1 April 2020 and 31 December 2020 with the number in the same period of 2019.

Data are presented as median (IQR), number (%) or RR (95% CI). Where frequency counts were below 5, or could be derived, absolute numbers were not presented. Analysis was performed using Stata V.14. Data were analysed on 21 July 2020.

**Role of funding source**
National Health Service England funded the rapid set-up of the real-time surveillance system and staff time to support its function, but had no input into the data analysis or interpretation.

**RESULTS**
Between Monday 6 January and Friday 28 June (175 days), a total of 1550 deaths of children were notified to the NCMD (as of 17 July 2020). From 1 March 2020, 968 requests for SARS-CoV-2 PCR results were requested from PHE on the previously agreed criteria (above); 412 children had at least one negative result identified, 25 had a positive result recorded at some point and for 531 no test was performed. Children who died with positive SARS-CoV-2 virology were less likely to be recorded as having white ethnicity (37.5% vs 69.4%, p=0.003) and were older (12.2 vs 0.7 years, p<0.0006) when compared with those who died with negative virology (table 1).

A total of 711 deaths occurred in the 77 days before the first 2020 national lockdown, compared with 839 deaths during lockdown (98 days) (figure 1). Children who died during lockdown had similar ages (table 2 and figure 2), sex, ethnicity, deprivation measures (figure 3) and locations as those dying pre-lockdown. However, during lockdown, fewer deaths occurred in hospital (73.8% vs 79.2%, p=0.016). A total of 756 deaths occurred in the comparable period in 2019, compared with 771 during lockdown (both covering the 91 days); and had similar ages, sex, ethnicity, deprivation measures and locations as those during lockdown. Overall rates of death were similar during lockdown compared with the 2020 period before lockdown (RR 0.93 (0.84 to 1.02)) and during lockdown compared with 2019 (RR 1.02 (0.92 to 1.13) (table 3)).

**Sensitivity analyses**
There was little evidence that the incidence of death was different in the two periods of lockdown when compared with before lockdown (p=0.141) or pre-pandemic in 2019 (p=0.773) (table 3).

When looking at the number of deaths split by the likely cause, over the whole lockdown period in comparison with the 2020 pre-lockdown and 2019 pre-pandemic periods, children had similar mortality rates after preterm birth or from malignancy, infection, trauma, substance misuse, suicide and sudden unexpected deaths (table 4). There was however some weak evidence that there was a higher rate of death after intrapartum events (RR 1.46 (0.97 to 2.20)), and stronger evidence that the risk of dying of an underlying condition was also reduced (RR 0.79 (0.65 to 0.97)) when compared with the pre-pandemic period of 2019; although wider, but compatible, CIs when comparing with the earlier pre-lockdown period of 2020 (RR 1.27 (0.84 to 1.94) and RR 0.85 (0.70 to 1.04), respectively).

Between 11 January 2020 and 26 June 2020, provisional ONS data reported 1152 deaths of children under 18 years occurring

![Figure 2](image-url) **Figure 2** Age of death, split by time period.

![Figure 3](image-url) **Figure 3** Deprivation measure (1–10) at death, split by time period.
in England, compared with 1492 deaths notified to the NCMD (29.5% more). Between 1 April 2019 and 31 December 2019, there were a total of 2498 childhood deaths reported to the NCMD; compared with a total of 2264 in the same period of 2020 (RR 0.92 (0.87 to 0.98), p=0.009).

### DISCUSSION

Overall child mortality was lower in 2020 than in 2019 although older children and those from black, Asian and minority ethnic (BAME) groups were more likely to have a SARS-CoV-2-positive test, consistent with other work.5 7 28

As with any routine data analysis, there are limitations to our analyses and interpretations. Child deaths in England remain rare, however the precision of the point estimate of overall mortality suggests that it is very unlikely that there has been a substantial change. The biggest limitation is likely to be that of missing data and case ascertainment, as, despite the rapid notification system, some late notifications may be missing. However, numbers reported in the NCMD are statutory and likely to miss only a handful of cases.14 The indications for testing for SARS-CoV-2 are complex and are influenced by clinical suspicion, availability of tests and local policy. It is possible that some children with complex disease (or underlying illness) were not tested as the death was expected or out of hospital. In addition, cause of death is based on limited notification data prior to completion of the full child death review process and so the categories presented should be interpreted with caution as they are based on limited information and some are likely to change when a fuller investigation is performed.21 Finally, we did not have complete data on some other measures (eg, ethnicity) so some degree of reporting bias is possible.

While the overall prevalence of child deaths with a positive SARS-CoV-2 antigen test in England is higher than estimated by others,5 15 many of the positive tests were performed in cases without recognised symptoms of COVID-19, so direct COVID-19 mortality cannot be assumed. In addition, many children were not tested for SARS-CoV-2. In total 1.6% of children dying during the lockdown period we examined were known to be SARS-CoV-2 positive around the time of their death, while a small additional number presented with one of the recognised syndromes associated with SARS-CoV-2 (eg, paediatric inflammatory multisystem syndrome temporally associated with...
SARS-CoV-2) but with a negative PCR. However, in contrast
to emerging data on the mortality seen in adults,29 this national
analysis demonstrates no measurable excess mortality in chil-
dren under 18 years, consistent with other work reporting on an
earlier epoch of the UK lockdown.5 We did see an increased risk
of a positive COVID-19 test in older children; and in those from
BAME backgrounds, consistent with other work.3 5 7 28 However,
in contrast to adult data, we did not see a higher prevalence of
underlying medical conditions in those children who died with
evidence of SARS-CoV-2 infection, or a measurable impact of sex
on mortality.30 Indeed, there is some evidence in this work that
dying from an underlying medical condition was less frequent
during the second period of lockdown than a comparable period
in 2019. This may be due to the unique nature of SARS-CoV-2
in younger children, or that social distancing and shielding
was effective in this group. Indeed, overall child mortality between
April and December 2020 is 8% lower than the corresponding
period in 2019 and further work is needed to identify the reasons
for this. Finally, concerns have been raised that social disruption
caused by the lockdown (eg, overcrowded accommodation or
those experiencing financial insecurity) might lead to increased
unexpected infant deaths or increased deaths from child abuse.
Our findings with the data collected thus far do not support
these concerns. Children with a positive SARS-CoV-2 test had
similar deprivation measures to those with a negative test.

CONCLUSIONS

In this analysis of child mortality in England, during the first
phase of the pandemic, there is little to suggest that there has
been excess mortality during the period of lockdown in England.
The apparent higher frequency of children from BAME groups
testing positive for SARS-CoV-2 is consistent with analyses in
adults, and further work will be needed to clarify the impact as
the pandemic continues. Changes in delivery of healthcare may
affect chronic conditions many months later, and the economic
impacts on socioeconomically disadvantaged children may take
time to become apparent. Ongoing surveillance of the overall
rates of child death and the likely causes and contributory
factors is essential as the pandemic continues, to provide rapid
support for policymakers and information for the public and
professionals.

Twitter Karen Luyt @KarenLuyt

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working-together-to-safeguard-children-revisions-supporting_documents/Working
Together_to_Safeguard_Children.pdf) and associated Child Death Review Statutory
& Operational Guidance https://assets.publishing.service.gov.uk/government/
uploads/system/uploads/attachment_data/file/859302/child-death-review-statutory-
and-operational-guidance-england.pdf). The NCMD legal basis to collect personal
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defined by GDPR Article 6 (e) Public task and 9 (h) Health or social care (with a basis
in law).

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of the first pandemic peak in England. Arch Dis Child 2020;105:archdischild-
2020-320042.


COVID-19 is characterized by lower levels of T-cell activation than infected adults. Eur


29 Comparisons of all-cause mortality between European countries and regions: January to June 2020 2020.

Web Appendix

National Child Mortality Database enhanced child death notification form

The National Child Mortality Database (NCMD) real-time surveillance system was based on an enhanced child death notification form. This was an existing statutory form used within the child death review (CDR) process to notify deaths to NCMD and to ensure the same dataset is collected for every death. It was enhanced by adding a COVID-19 specific module. This module was developed with clinical input and aimed to help identify children who died of or with COVID-19 (confirmed or suspected) and those where COVID-19 may have been a contributory factor in the death for example changes to services as a result of the lock-down which may affect accessibility. NCMD provides ongoing training and support to the Child Death Overview Panels (CDOPs) for how to use the updated notification form and the alert system through webinars, training materials made available online on the NCMD website (https://www.ncmd.info/2020/07/16/guidance-notification-n/) and through the established communication channels.

The enhanced COVID-19 module was designed, developed, tested and deployed into the live system within 10 days and from 1st April 2020 any deaths notified to NCMD were reported using the new child death notification form. A full copy of the revised form with the additional COVID-19 module included can be found at https://www.gov.uk/government/publications/child-death-reviews-forms-for-reporting-child-deaths

Categorisation and coding of deaths notified to NCMD

The information in the enhanced notification form allows for more comprehensive data collection of child death information at the point of notification. A panel of core NCMD clinical and CDR experts was established to carry out daily review and categorisation of all cases notified to the NCMD.

All deaths as notified to NCMD are categorised using one or more of the following broad categories for each notified death:
- Malignancy
- Preterm
- Intrapartum or pre-natal event
- Infection
- Trauma
- Substance Misuse
- Suicide or Self Harm
- Underlying health condition
- Positive Test Child
- Positive Test Mother
- Positive Test Household
- Potential COVID-19 factor
- Insufficient information

Definitions for Cause of Death Categories

<table>
<thead>
<tr>
<th>Malignancy</th>
<th>Did the child have a known active malignancy?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm</td>
<td>Was the baby born before 37 weeks and died before discharge from hospital?</td>
</tr>
<tr>
<td>Intrapartum or pre-natal event</td>
<td>Was the death related to intrapartum or pre-natal events? E.g. Perinatal asphyxia, meconium aspiration, shoulder dystocia</td>
</tr>
<tr>
<td>Infection</td>
<td>Was the death related to likely infection/sepsis including bacterial, viral and other organisms?</td>
</tr>
<tr>
<td>Trauma</td>
<td>Is the death related to trauma E.g. Possible Non-accidental Injury (NAI), unintentional suffocation/strangulation, Vehicle collision, Drowning, Fire/burns/electrocution, Poisoning (prescription or non-prescription drugs), Medical or surgical complications, Falls, Injuries from falling objects, Animal attack, Natural disaster, Terrorism</td>
</tr>
<tr>
<td>Substance misuse</td>
<td>Is the death related to substance misuse / overdose? E.g. Older children who may take drugs recreationally or as a method of potential suicide; Younger children who access medications at home unintentionally</td>
</tr>
<tr>
<td>Suicide or self-harm</td>
<td>Is the death the result of apparent suicide or self-harm?</td>
</tr>
</tbody>
</table>
SUDIC
(Sudden Unexpected Death in Childhood)

- Was the death sudden and unexpected with no immediately apparent natural cause? (SUDIC)

Underlying health condition

- Does this child have a significant underlying health condition? E.g. Asthma, Chronic respiratory condition, Diabetes, Cardiac issues, Renal problems, Gastro-intestinal problems (e.g. short gut), Transplant recipient, Rare disease, Congenital anomalies

This case review and coding process also includes the analyses of free text information from the notification form, which provides detailed account of the events and circumstances of death. In some cases, additional information, either from the CDOPs or the notifying professionals, is requested by the NCMD team to complete the record to help with better and more rapid intelligence. Direct communication between the NCMD clinical team and the clinical staff involved in the care of the children who have died has been welcomed by the staff involved and allows the team to collect more detail more quickly than would otherwise have been possible.

Data collected by NCMD from 1st of April to 30th of June 2019 has been subjected to the same process of categorisation, which has also been applied to data collected on deaths that occurred from 1st of January 2020.

Data linkage and reporting

All child deaths are categorised as definite or potential COVID-19 related, including both direct and indirect factors. These cases are linked to SARS-CoV-2 test results through daily feeds from Public Health England’s virology database. This information feeds into daily and weekly official reporting from NCMD to the National Health Service and Public Health authorities in England to inform actions and policies for the health and well-being of children.

The statutory requirement to submit notification of a child death to NCMD within 48 hours of CDOPs being notified means that the information on all child deaths received through the CDR process provides the most complete and real time information on child deaths at a national population level. The median time from a child death occurring to notification to NCMD is 1 day.