# Missed nursing care in new-born units: a cross-sectional direct observational study

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# Abstract

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1. **Background**: Improved facility-based care for sick or preterm newborns is central to efforts to reduce
2. newborn mortality and nurses are essential to the delivery of safe and effective care. Nurse shortages
3. and high patient workloads may consciously or unconsciously result in some nursing tasks being left
4. undone, referred to as missed care. The aim of this study was to assess and quantify nursing care
5. delivered to sick newborns and identify missed care using direct observational methods.
6. **Methods**: A cross-sectional study utilising direct-observational methods for 216 newborns admitted
7. within newborn units in six health facilities in Nairobi, Kenya was used to determine which tasks were
8. completed. We report the frequency of tasks done and a nursing care index (NCI) comprising an
9. unweighted summary score of nursing tasks done for each baby to explore how task completion is
10. related to organisational and newborn characteristics.
11. **Findings**: The nursing tasks most commonly completed included handing over between shifts (97%),
12. checking and where necessary changing diapers (96%). Tasks with lowest completion rates included
13. nursing review of newborns (38%), cord care (38%), turning/repositioning (38%), cleaning eyes and
14. checking for discharge/infection for babies on phototherapy (38%), oxygen saturation monitoring (34%)
15. and skin assessment for babies on phototherapy (15%). Overall the mean nursing care index (NCI) was
16. 60% (95% CI 58 – 62) with a minimum threshold of completing at least 80% of tasks occurring for only
17. 14% of babies. Private sector facilities had a median ratio of babies to nurses of 3, with a maximum of 7
18. babies per nurse. In the public sector, the median ratio was 19 babies and a maximum exceeding 25
19. babies per nurse. In exploratory multivariable analyses, ratios of ≥ 12 babies per nurse were associated
20. with a 24-point reduction in the mean NCI compared with ratios of ≤ 3 babies per nurse.
21. **Discussion**: Observations indicate a significant proportion of nursing care is missed with potentially
22. serious effects on patient safety and outcomes. Given that nurses caring for fewer babies on average
23. performed more of the expected tasks, addressing shortages of human resources seems key to improve
24. care and ultimately help reduce neonatal mortality. 49

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1. **Introduction**
2. Although progress has been made globally in reducing under 5 mortality deaths in the first twenty-eight
3. days of life (the neonatal period) declined at a slower rate, particularly in sub-Saharan Africa.[1,2] As a
4. consequence, neonatal mortality contributes about 45% of mortality for children under-5 years.[3] A
5. recent review by Bhutta and colleagues indicated that high impact low cost interventions could avert more
6. than 71% of neonatal deaths with 82% of this effect being attributable to facility-based care[4]. However,
7. quality of care for newborns in health facilities has been reported as poor in low and middle-income
8. countries (LMIC).[5][6] Most of these LMIC studies have focused on resource availability and processes of
9. medical care with little detailed information on the quality and nature of care provided to sick newborns
10. by nurses.
11. LMIC, especially sub-Saharan Africa, are also facing critical health workforce shortages with the global
12. shortage estimated at over 7 million.[7] In Kenya, Wakaba and colleagues reported that public sector
13. nursing densities ranged between 0.008 to 1.2 per 1000 population across counties[8] compared to an
14. internationally suggested minimum health workforce threshold of 4.5/1000 population for doctors,
15. nurses and midwives to achieve the Sustainable Development Goals (SDGs).[9] Nurses in hospitals are
16. vested with the responsibility of delivering interventions prescribed by other providers (doctors,
17. nutritionists etc) in addition to providing nurse initiated interventions[10]. In higher income countries
18. there is a growing body of knowledge on the important contribution of nursing care in hospitals to patient
19. safety,[11] outcomes and care quality,[12] with an association between nursing shortages and care being
20. delayed or omitted.[13] This latter phenomenon has been described as ‘implicit rationing’, ‘missed care’,
21. ‘unmet nursing care needs’, ‘care left undone’, or ‘task incompletion’.[14] Hereafter, we use the term
22. missed care to encompass all these terms. These prior reports on missed care are based on nurse surveys,
23. only two have focused on newborn care provision but within neonatal intensive care and they illustrate
24. basic nursing care was missed with unexpected rise in patient volume/acuity and interruptions to respond
25. to emergencies as the most common reason for care being missed.[15,16] Similar findings have been
26. reported in the only study we identified from Africa with the main nursing tasks left undone being
27. comfort/talking to patients, educating patients and family and developing/updating nursing care
28. plans/pathways[17]. Authors of a recent systematic review recommended that researchers need to
29. develop objective observational methods for quantifying missed care to advance this field further.[14]
30. Our aims were therefore to explore the extent of nursing care delivered to sick newborns in hospitals in
31. a LMIC, going beyond prior reports that have focused predominantly on medical aspects of care,[18,19][5]
32. and develop and use direct observational methods to identify and quantify the nature of missed care in
33. this setting. In doing this we had a secondary objective to explore how nursing shortages may be directly
34. impacting neonatal nursing care provision.
35. **Methods and analysis**
36. This was a cross-sectional study utilising direct observational methods to describe the essential neonatal
37. nursing care given to individual sick newborns in Nairobi, Kenya. The study protocol is described in detail
38. elsewhere.[20]

# Establishing essential nursing care practices

1. In earlier work Kenyan nursing experts and policy makers developed draft minimum standards for
2. neonatal nursing care with recommendations on which tasks should be done and their frequency over 24
3. hour periods (see supplementary table 1).[21] Although these standards were initially developed by a
4. small group of stakeholders (n=12), they have since been presented to wider nurse expert stakeholder
5. groups and representatives from Ministry of Health, training institutions and development partners with
6. interests in newborn health (UNICEF, WHO) for validation and were considered acceptable standards.
7. These standards take account of three different levels of illness severity in hospitalised newborns with
8. categories A: the most acutely ill; B the moderately ill; and C the least ill. The nursing experts further
9. agreed by consensus that if a baby receives 80% or more of recommended nursing care this would
10. comprise a minimum threshold for adequate nursing care delivered.[21] Standards for provision of nursing
11. care have generally been neglected and these are to our knowledge the first explicitly developed for
12. hospital care in Kenya. While these guidelines were developed for the Kenyan context the absence of
13. reports in the literature of standards developed for similar settings suggests they may have wider value
14. as has been the case for clinical guidelines.[22]

# Study sites and data collection

1. This study drew on earlier work that identified the facilities (n = 31) providing inpatient newborn care for
2. 24 hours, 7 days a week (hereafter referred to as 24/7) to the population of Nairobi.[23] [24] Amongst
3. these hospitals 13/31 had more than 100 neonatal admissions annually and they provided care to over
4. 96% of the entire sick-newborn population accessing care within Nairobi County. These 13 facilities were
5. considered eligible for our study. We stratified these by workload (newborn admissions per year <=500
6. low; >500 high) and sector (the public, private-not-for profit, hereafter referred to as mission hospitals,
7. and private-for-profit, hereafter referred to as private hospitals). We purposively selected 6 hospitals, 2
8. from each sector, ensuring one high and one low workload facility in each sector. Purposive selection of
9. hospitals was used as part of our aim was to span each sector to maximise variation in nurse to baby ratios
10. and, because the proposed work was deemed potentially sensitive, we required strong support of the
11. hospital administration. We used findings from a previous study that explored the readiness of hospitals
12. (their organisation and resources) to provide a ‘structural quality score’ for each facility to help
13. characterise the 6 selected facilities.[24]

# Study population and sampling strategy

1. All newborns admitted within the newborn unit in the 6 selected health facilities over the specific study
2. period formed the potential study population. However, newborns who were at high risk of death within
3. 12 hours, as defined by the clinician in-charge (extremely low birth weight babies, babies requiring
4. frequent resuscitation), needing specialised care/treatment (e. g scheduled for surgery, requiring transfer
5. for ventilation, or with gross congenital malformations) were deemed ineligible for ethical reasons and as
6. the draft minimum standards were not applicable. Newborns whose guardian or nurse declined consent
7. were excluded from the study.
8. Nurse staffing and routine activities may vary between weekdays and weekends and night and day. Care
9. within newborn units is also often organised so that babies with different levels of disease severity are in
10. different ward sections/rooms.[21] In each hospital, a random sample of twelve shifts/time blocks of 12
11. hours (144 observation hours per hospital) were selected from within a 3 week period. We used stratified
12. random sampling to ensure we observed 3 weekday day shifts, 3 weekday night shifts, 3 weekend day
13. shifts and 3 weekend night shifts. Pilot data collection exercises confirmed it was logistically feasible for
14. one observer to make direct observations of three babies located in adjacent cots in the same ward area
15. for these 12 hours’ time blocks. Since care within the newborns units is typically organised so that babies
16. with similar disease severity (category A, B, C) are co-located in the same ward area, we therefore used
17. purposeful sampling to ensure that for each shift group (eg. the 3 weekday day shifts) one focused on
18. observing Category A babies, one focused on Category B babies and one focused on category C babies
19. with three babies who met the inclusion criteria purposefully identified at the start of the 12-hour time
20. block for this purpose (supplementary figure 1). The 12-hour periods were selected because they span
21. nursing shift change overs and allowed observation of care round-the-clock. Detailed sampling and study
22. procedures are provided in detail elsewhere. [20]

# Data collection

1. Data were collected between 1 September 2017 and 30 May 2018. We documented how often certain
2. nursing tasks (listed in table 3) were undertaken in a 12-hour shift (7am -7pm or 7pm to 7am) using an
3. observation checklist. The observers spent 1 week in the hospital before the 3-week period during which
4. 12-hour shifts were randomly selected for observation. The familiarisation period enabled observers to
5. learn the hospital environment and routines, introduce the study and gain consent from nurses. This one-
6. week familiarisation period also allowed the staff to become familiar with the observers aimed at reducing
7. nurses’ efforts to modify their behaviour (the Hawthorne effect). Team or task nursing was the commonly
8. used approach rather than primary nursing in provision of nursing to newborns. Therefore, over the 12-
9. hour observation period, the care provided to 3 babies was typically provided by multiple nurses. As such
10. the baby : nurse ratio over a 12-hour shift was computed by dividing the total number of babies admitted
11. in the unit with the number of nurses working during the shift. For instance, if there were 30 babies in the
12. newborn unit and 3 nurses were providing care during a 12-hour shift, the resulting baby : nurse ratio was
13. 10 babies to 1 nurse. Majority of the nurses practicing within newborn units are registered general nurses
14. trained at a diploma level (RNs) with no specialist training in newborn care. Within the study hospitals,
15. we did not observe significant variation in the process of allocation of qualified nurses to different levels
16. of acuity based on training or years of experience.
17. For each newborn selected for direct observation, the medical records were first reviewed and data on
18. the diagnosis, disease severity and any specific interventions (e.g. requirements such as phototherapy or
19. oxygen) were collected. This initial information allowed the observer to determine the nature and number
20. of expected nursing tasks to be delivered for each baby based on their illness severity (category A, B or C),
21. the interventions they were receiving and the nursing care standards. We categorised tasks as
22. nursing/clinical tasks that require physical interaction with the baby or mother/family member (for
23. instance feeding the baby, taking vital signs or providing counselling) or documentation tasks (e.g.
24. recording of vital signs) for which the observer checked nursing and medical records. Tasks are listed in
25. table 3 and the observer recorded if a task was done or not done by a nurse (scored 0/1).
26. Observations were stopped if a baby was discharged, transferred out of a section or changed condition
27. and became critically ill (when the minimum draft nursing standards did not apply). However, the data
28. collected up to the point of exit were used to re-adjust denominators (see below). Similarly, if a baby’s
29. care changed but they remained in the same observation area, this change was documented and the
30. expected number of tasks revised. At the end of each 12-hour shift nursing and medical records were
31. reviewed for evidence of documentation tasks.
32. Observations were made by a nutritionist, considered an appropriate cadre because they are familiar with
33. the hospital environment, equipment, care processes, medical language, and would be considered a
34. professional rather than an ‘outsider’. Moreover, we felt observing sick babies might be less distressing
35. for a person with a health professional background. Using an observer who was not a nurse or clinician
36. we felt might help overcome bias introduced by the observer relating their observations to their own
37. standards of practice or being influenced by shared professional allegiances.

# Sample size and analysis

1. Our primary objective was to assess and quantify nursing care delivered to sick newborns and identify
2. missed care. As such, we based our sample size estimations on the precision around proportions for
3. individual tasks reported as done (or not done). We estimated that observing 216 babies (36 per hospital
4. for 12 hours) would provide denominators of 108, 216 and 432 for the total number of times a task should
5. be done (observed) assuming the task was required for all babies and standards indicated the task should
6. be done once, twice and four times per 24 hours respectively. Assuming a design effect of 2 to adjust for
7. clustering of observed tasks within hospitals would allow us to report precision (95% confidence intervals)
8. around a statistically conservative proportion of 50% of expected tasks done of ± 13.4%, 9.4% and 6.7%
9. respectively. The actual denominator for some tasks would however, depend on the patterns of use of
10. specific interventions (e.g. phototherapy, and see Table 3) reducing our reported precision. In the specific
11. case of feeding, babies were often observed to have more than one type/route of feeding as an option.
12. In such cases, we pooled data from different types of feeding (nasal gastric tube feeding, cup and spoon,
13. and breastfeeding) so that a baby was documented as fed if they were observed to receive feeds using
14. one or more of the above routes at the expected frequency.
15. For our primary objective, we pool our data across all babies observed and report as a proportion (with
16. corresponding 95% confidence intervals adjusted for clustering at the hospital level) the number of times
17. a specific task was observed as done divided by the number of times it was expected to be done. Some
18. tasks (e. g vital signs monitoring) should be done on all babies irrespective of the severity of illness /
19. severity category and so the proportions reported represent aggregate measures across all babies and
20. severity categories (table 3). Other tasks (e.g IV fluid or oxygen monitoring) might only be required in
21. babies in severity category A and B. Proportions reported therefore reflect performance in such sub-
22. groups (with appropriate cluster adjusted confidence intervals). 202
23. In secondary analyses we created for each baby a denominator based on the total number of expected
24. nursing tasks that should have been delivered based on the standards and the number of interventions
25. each baby was receiving. This baby-specific denominator was then used to determine a proportion of
26. expected tasks actually observed to be completed for each baby. This created a summary unweighted
27. performance measure (all tasks given equal weight), the Nursing Care Index (NCI), at individual level for
28. which the denominator varies by diagnosis and case severity. As indicated above during the development
29. of the minimum standards, local experts agreed that babies receiving 80% or more of their expected care
30. tasks met a minimum threshold for adequate nursing care delivered.[21] We therefore created a binary
31. variable representing adequate nursing care delivered based on whether babies’ NCI was 80% or more
32. and report the proportion of babies receiving adequate nursing care delivered. In further analyses we use
33. the NCI to explore associations between this summary measure of care delivered at the baby level with
34. characteristics of the hospital (sector), of the shift (the baby: nurse ratio, categorised into <3 babies; 4 –
35. 11 babies and >12 babies per nurse), and of the baby (post-natal age categorised into <= 3 days; 3-7 days
36. and 8-28 days, birth weight categorised into ≤1499 grams; 1500 – 1999 grams; 2000- 2499 grams and
37. ≥2500 grams and severity category). To define the baby: nurse ratio categories, the distribution of data
38. on baby:nurse ratio was used to ensure a reasonable number of observations in each category. Linear
39. regression was used to explore associations between the NCI (dependent variable) and these hospitals,
40. shift and baby characteristics in unadjusted models. Multivariable models were built to explore
41. associations further using a step-wise forward selection procedure. Babies per nurse was included a priori
42. as an independent covariable in preference to hospital identity with which it is strongly associated in our
43. dataset. We therefore could not include hospital identity as a fixed effect in the regression models. We
44. opted to use babies to nurse ratio, while acknowledging that this is also a proxy for sector (see figure 1)
45. in our dataset, as staffing ratios are a key parameter tracked and reported in most missed care literature.
46. A formal hierarchical model was deemed inappropriate due to the limited number of clusters (n=6
47. hospitals) with 25-40 clusters being recommended for such an analytical approach. [25] To build our
48. multivariable model we used the Hosmer-Lemeshow criterion of a likelihood ratio test (LRT) with P value
49. of <0.2 in the univariable analysis to identify possible covariable of interest. We added covariables starting
50. with those with the strongest association in univariable analyses. Likelihood ratio tests (LRT, p value of
51. <0.05) were used to determine whether additional factors added to the model should be retained in a
52. final model. In a linked exercise the LRT was also used to examine whether babies per nurse be included
53. as a continuous or categorical variable. All analyses were conducted using the statistical analysis software,
54. STATA, V.13. 235
55. Scientific and ethical approval for this study was granted by the Kenya Medical Research Institute Scientific
56. and Ethics Review Unit. Written informed consent was sought from both mothers and nurses while
57. hospital management teams provided permission to conduct the study in the hospitals.

# Results

1. Data were collected from six hospitals spanning public, private and mission sectors. Of the 13 hospitals
2. that met our inclusion criteria as possible study hospitals, we identified 6 hospitals to be included in the
3. study. One medium sized private hospital (657 annual admissions) declined to participate in the study
4. citing hospital policy on access of medical records and patient privacy, a replacement hospital with similar
5. characteristics was identified from the remaining 7 hospitals. No refusals from families/caregivers were
6. reported. The annual neonatal workload for these hospitals ranged from 123 – 1438 newborns admitted
7. per year while the annual total deliveries ranged from 1398 - 6620 births. In a previous study we assessed
8. the availability of basic infrastructural resources for providing care (structure index) in accordance with
9. Kenyan guidelines.[24] The availability of basic infrastructural resources was considered at least good
10. (>80%) in all 6 hospitals and varied from 81% - 92%. The two mission hospitals were heterogenous, one
11. was more similar to a private hospital while the other had similar staffing ratios and workloads to those
12. in public hospitals. A summary of hospital characteristics is presented in table 1.
13. A total of 216 babies were observed (described in Table 2 and supplementary table 2 for hospital specific
14. results) against a direct observation checklist with an equal number of babies (72) in each sector. The
15. majority of the babies were aged less than 7 days 61% (129) while 33% (70) and 59% (126) weighed <1500
16. grams and were born via caesarean respectively. Of those delivered via caesarean section, 42% (53/126)
17. were from the private sector. The primary reasons for admission were prematurity/low birth weight 43%
18. (92), respiratory distress syndrome 19% (42) and severe jaundice 11% (24). There were relatively equal
19. numbers of observations across the sample stratifying variables (sector, neonatal care category and
20. nursing shift). A baby was only observed for one 12-hour shift and not in any subsequent periods.
21. In table 3, we present the proportions for when specific expected tasks were observed to be completed
22. by nurses using data pooled across all babies observed. The tasks most commonly completed by nurses
23. were nursing care handing over for babies between shifts (97%), checking and where necessary changing
24. diapers (96%), checking eyes for damage from phototherapy, turning of babies on phototherapy (91%),
25. and supporting mothers practicing Kangaroo Mother Care (KMC) (91%). The least done tasks included
26. nursing review of newborns (38%), cord care (38%), turning/repositioning (38%), cleaning eyes and
27. checking for discharge/infection for babies on phototherapy (38%), oxygen saturation monitoring (34%)
28. and skin assessment for babies on phototherapy (15%). Of the vital signs, oxygen saturation (required 6
29. hourly for babies on oxygen or in category A or B) was the least done 34% (49/144) but pulse, respiratory
30. rate and temperature monitoring (required for category A, B and C babies) were also done on fewer than
31. 60% of occasions. For documentation tasks, treatment and fluid administration were the most
32. documented, 97% and 91% of the episodes respectively, while the least documented tasks were turning
33. (27%) and communication with the parent (25%). Supplementary table 3 describes in detail the number
34. of expected tasks as per neonatal nursing guidelines and the proportion of these tasks completed by
35. neonatal care categories and hospital sector. The median number of expected tasks (effective
36. denominator) per baby was 23 (IQR 20 -28, minimum and maximum 16 and 44 respectively). For all 216
37. babies observed the mean nursing care index (NCI) was 60% (95% CI 58 – 62; range 24 - 96) (Table 4).
38. Variations in the NCI became apparent when observations were stratified by the sector and day/time of
39. observation as well as by baby specific characteristics (e.g. clinical category) and by the baby to nurse ratio
40. on the whole ward at the time of the observations. For example, higher proportions of care were done in
41. the private sector (mean 74%; 95% CI 71-77), in the 1-3 babies/nurse category (mean 73%; 95% CI 70 -
42. 76), and among sicker babies – category A (mean 63%; 95% CI 59 – 68). A generally similar pattern was
43. observed if nursing/clinical tasks and documentation tasks were considered separately with a suggestion
44. that more documentation tasks were done for category A babies (mean documentation specific NCI 68%;
45. 95% CI 62 -73) compared to category C babies (mean documentation specific NCI 50%; 95% CI 45 - 56). To
46. explore the proportion of babies receiving a minimum threshold of adequate nursing care delivered, we
47. applied our previously defined cut-off of ≥80% of the required nursing tasks per baby being done. Overall
48. 14% (95% CI 10 -20) of the babies received a minimum threshold of adequate nursing tasks done by this
49. criterion. While none of the babies in the public sector met this criterion, 31% (22) and 13% (9) of the
50. babies in the private and mission sectors achieved this threshold respectively. Although sub-optimal,
51. higher proportions of babies who were sicker (category A, 23% (16)) and where staffing ratios were 1-3
52. babies per nurse (32% (27)) were observed to receive minimum threshold of adequate nursing care. (table 292 4).

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# Hospital and baby characteristics associated with mean nursing care index

1. Initial univariable analyses suggested that a lower NCI was associated with a baby having a weight ≥1500
2. grams, higher baby to nurse ratios on a shift (a 26-point reduction in mean NCI when there were ≥12
3. babies/nurse compared with 1-3 babies/nurse) and observations made in the public sector compared with
4. the mission sector (22-point reduction in the mean NCI) (Table 5). Meanwhile a higher NCI was associated
5. with a post-natal age > 8 days and care in the private sector. In the multivariable analysis that included
6. baby to nurse ratio but excluded sector babies age, neonatal care category and nurse: baby ratio were
7. identified as associated with the NCI based on the LRT (p value 0.005). In this multivariable model, a baby
8. being in category C was associated with an 8-point reduction in mean NCI when compared to category A
9. babies and when there was ≥12 babies/nurse or 4-11 babies/nurse this was associated with a 24-point
10. and 12-point reduction in NCI when compared with shifts when there were 1-3 babies/nurse. A post-natal
11. age > 8 days was associated with a 7 points higher NCI when compared to babies aged ≤2 days.
12. The strong apparent relationship between NCI measured for each baby and the baby to nurse ratio of the
13. shift being observed was further explored in a simple scatter plot (Figure 1). This demonstrates the strong
14. relationship between sector and baby to nurse ratio and thus the relationship between sector and NCI
15. apparent in univariable analysis. In the private sector the median ratio was 3 babies to 1 nurse with a
16. maximum ratio of 7 babies to 1 nurse. In the public sector the median ratio was 19 babies to one nurse
17. with a minimum of 10 and a maximum exceeding 25 babies per nurse. 312

# Discussion

1. The aim of this study was to quantify nursing care tasks that can be observed that were delivered to sick
2. newborns and identify missed care (tasks done or left undone) within a set of Kenyan newborn units. Task
3. completion varied greatly overall and across hospital sector and newborn illness severity category. We
4. observed omission of nursing tasks that might directly influence the baby’s outcome, for instance, feeding,
5. monitoring of vital signs and appropriate use of interventions like fluids and oxygen. This highlights
6. potentially critical safety issues, although our study was not designed to explore the effects on patient
7. outcomes. These specifically missed tasks are likely to be compounded by indirect effects of missed care
8. linked to poor communication between nurses and patients and among teams of carers.[27]
9. Communication with and education of mothers or caregiver’s, such as explaining the baby’s illness and
10. management and teaching them how to safely feed their baby, was provided on less than half the
11. occasions expected. These aspects of missed care may adversely affect mothers’ experience of care and
12. influence babies’ early recovery and longer term maternal-neonatal bonding.[27,28] Inter and intra-
13. professional communication is likely undermined by, for example, poor documentation and inability of
14. nurses to engage in medical rounds. Both may adversely affect the teamwork that is critical to providing
15. safe, effective care in high pressure clinical environments.[29,30]
16. In our secondary analysis we developed a measure that aggregated all the (observable) tasks done per
17. baby, the NCI. The mean proportion of expected tasks done per baby was 60% overall. The threshold
18. recommended by local experts representing minimum threshold of adequate nursing care delivered was
19. rarely achieved (14% babies). The NCI varied in association with sector being highest in the private sector.
20. However, there was a strong association between sector and the number of babies that each nurse was
21. caring for. No babies were observed in the private sector when there were >7 babies per nurse while no
22. babies in the public sector were observed when there were <10 babies per nurse. Failure to take account
23. of this dramatically different nursing workload could, mistakenly we believe, be interpreted as suggesting
24. that nurses generally perform better in the private sector. Focusing on the number of babies per nurse
25. our findings suggest this strongly related to the proportion of tasks completed (NCI). Our model suggests
26. a 24% reduction in the NCI when there was one nurse per 12 or more babies compared with one nurse to
27. up to 3 babies. We believe that the relationship between staffing levels and care received also mediates
28. the apparent effect of shift timing on NCI (with care at night scoring lower than in the days). The obvious
29. implication is that to improve quality of care, it is imperative that workforce deficits are addressed. These
30. findings contribute to the growing body of evidence linking inadequate staffing and missed care. Studies
31. undertaken in Sweden,[31] across Europe,[32] and in England[13] have reported associations between
32. staffing and nursing care left undone. Additionally, the number of patients per nurse and the number of
33. nursing care hours per patient day have been associated with missed care.[33] [34] However, most of this
34. literature is based on data from nurse surveys of self-reported missed care and are from High Income
35. Country (HIC) settings. While improving nurse numbers is key, our data illustrate considerable variation in
36. the NCI with the same nurse to baby ratios (Figure 1). This suggests there is also some potential for
37. improving care by learning what steps nurses take in some settings to achieve high performance despite
38. significant challenges through efforts to study ‘positive deviants’.
39. Additional findings from our secondary analysis suggest that babies who were more severely ill (Category
40. A) received higher levels of nursing care (8% higher NCI) compared to stable babies (Category C) in the
41. adjusted multivariable analysis. We hypothesise that nurses may feel stable babies are out of danger and
42. hence prioritise care provision to babies who are perceived to be at higher risk of death. These findings
43. are consistent with parallel ethnographic work conducted by our team that suggests nurses have to
44. engage in ‘sub-conscious triage’ when the volume of work is overwhelming[35] as well as with wider
45. literature reporting that nurses often prioritise medical or technical interventions at the expense of social
46. and relational aspects of care.[27] New technologies are widely felt to offer great promise for improving
47. newborn outcomes but are most likely to be used in the sickest babies. Their introduction may further
48. increase time spent on this group to the neglect of babies who are apparently less ill, potentially putting
49. this group at risk of deterioration, or delay to their recovery. Moreover, these technologies still require
50. human resources to support their use and could potentially exacerbate the general problem of missed
51. care in settings with critical workforce deficits. While our data illustrate the extent of missed care taking
52. the perspective of the baby, there are also likely to be important effects on nurses themselves of such
53. high workloads and their own perception of failing to meet professional expectations of care. The
54. exhaustion and burnout that are potential consequences are important detrimental effects on the
55. emotional and psychological wellbeing of nurses[36] and on sustainability of this crucial workforce.
56. The gaps in care we highlight underscore the urgent need for system strengthening to support the nursing
57. workforce in LMIC and for quality improvement initiatives and research on service redesign to focus on
58. nursing. As part of a wider programme of work, we observed that nurses’ time is often taken up by tasks
59. that are not necessarily core to the nursing role. Examples include clerical tasks such as organising patient
60. files, receiving telephone calls and billing, collecting supplies from stores and ward cleaning of baby cots
61. and equipment. These non-patient facing activities take up a significant amount of their time.[35]
62. Opportunities therefore exist to refocus nursing practice on skilled tasks for which they are specifically
63. trained and re-assign some tasks to other workers. Such approaches may enhance the professional status
64. of nurses and make most efficient use of human resources through, for example, specific forms of task
65. sharing. In high income countries health care assistants (HCAs) support nursing care provision by
66. undertaking non-technical tasks.[37,38] In LMICs, including Kenya, task sharing/shifting from doctors to
67. clinical officers (physician assistants) and nurses has been implemented to support care provision for HIV,
68. TB and non-communicable diseases.[39,40] However, delegation of some tasks to a supportive cadre
69. needs careful consideration to ensure adequate supervision and patient safety.[41] Furthermore, it should
70. be clear that addressing the nursing workforce deficit is the first priority which may be complemented by
71. introducing support workers.
72. Our results need to be interpreted in light of the following limitations. The use of direct observational
73. methods limited the nursing tasks assessed to those that can be observed and we might have
74. underestimated the magnitude of tasks done (or not done). Interestingly we did note that care was
75. sometimes documented as done when this was not corroborated by our observations, suggesting
76. observations may be more accurate than record review. Observations might be influenced by observer
77. bias and are at risk of Hawthorne effects. We developed through extensive piloting a highly structured
78. checklist and provided careful training to help overcome these limitations in addition to a one-week
79. familiarisation period for observers in each hospital before the start of formal observations. We did not
80. evaluate inter-observer variability within the main study. A study team member and the 4 observers
81. recruited did train together on the observational methods over a one-week period during which we
82. evaluated the observers’ performance against the study team member as the reference. Similar
83. evaluations were conducted for 2-days in each hospital during the one-week familiarisation period before
84. start of the actual data collection. In these training exercises observers demonstrated >95% concordance
85. with the observations of the study team member. During data collection there were weekly supervision
86. visits to ensure consistency in data collection and adherence to study standard operating procedures.
87. We purposefully selected a relatively small sample of hospitals in one city that varied by sector and
88. workload (annual admissions 106 – 1319) and excluded the sickest babies from our sample. This selection
89. limits the generalizability of our findings although extremely sick newborns are a minority on the wards
90. we studied. Despite the small number of hospitals studied, we feel the inclusion of different sectors with
91. different organizational capacities provides useful insights on the nature and magnitude of missed care.
92. The very different baby to nurse ratios found in the private and public sectors does however, preclude
93. our ability to explore any effect that the sector may have on our missed care measures and we make the
94. assumption that it is baby to nurse ratio that is the major determinant of missed care. Further, the strong
95. association between sector and baby to nurse ratio limited our ability to include a fixed effect for hospital
96. identity in the multivariable analysis as one way of adjusting errors for clustering of observations within
97. hospitals. As a result, the findings of our exploratory analyses must be interpreted very cautiously
98. although they are consistent with wider literature on the association between nurse staffing and missed
99. care. The nursing care index we used may also be criticised for not taking account of the relative
100. importance of some tasks (all are given equal weight). It does however have the advantage of being
101. intuitive and easily understood and is based on tasks an expert panel proposed were all relevant to
102. achieving a minimum standard of care while the allocation of task-specific weighting values could itself be
103. very contested and has not to our knowledge been attempted in prior work on missed nursing care.

# Conclusion

1. Our work addresses an important gap in the global literature on quantifying the care delivered by nurses
2. using direct observational methods. To the best of our knowledge this is the first such study in a low
3. resource setting and it drew on development of local, contextually relevant standards. We observed great
4. variation in task completion with potentially important implications for patient well-being and safety.
5. Aggregating nursing tasks within babies, average task completion was 60%. Our exploratory analysis
6. suggests a strong relationship between the high levels of missed care observed and the high baby to nurse
7. ratios found especially in the public sector. Improving quality of care and its contribution to newborn
8. survival clearly demands an expansion of the nursing workforce, potentially complemented by additional
9. human resource innovations. Failure to address critical workforce issues will mean missed care remains
10. common and undermine efforts to deliver high impact, low cost interventions for small and sick babies.
11. While the focus of our work was newborn units in one city our wider experience suggests similar
12. challenges are faced on paediatric and other hospital wards in Kenya and probably many other African
13. settings. Our data therefore lend support to initiatives highlighting the critical role nurses play in care
14. provision such as the ‘Nursing Now campaign’, a global campaign aiming to improve health by raising the
15. profile and status of nursing worldwide.[42] 433

# Authors’ contributions

1. DG, ME and GAVM designed the study with contributions from AO, ET, DJ and SB. DG and GS were
2. responsible for the coordination and supervision of data collection. DG and ME wrote the initial draft
3. manuscript with substantial and critical input from all co-authors. All authors read and approved the final
4. version of the manuscript.

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5. design, writing of the report and in the decision to submit the manuscript for publication. The
6. corresponding author had full access to all the data in the study and had the final responsibility for the
7. decision to submit the manuscript for publication. 447

# 448 Conflict of interest statement

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None

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452 **Figures**

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Figure 1: Nursing care index for each baby by number of babies per nurse across sectors

1. Table 1: Hospital characteristics by workload and availability of resources to provide care (structure index)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hospital** | **Sector** | **Cots** | **Annual**  **newborn admissions** | **Annual**  **total deliveries** | §**Structure**  **index (score 0 - 100)** | **¥Mortality**  **by sector** |
| Hospital 1 | Mission | 8 | 1438 | 6620 | 91 | 5.9 |
| Hospital 2 | Mission | 15 | 160 | 1305 | 87 | 5.9 |
| Hospital 3 | Private | 30 | 1816 | 2273 | 92 | 7.3 |
| Hospital 4 | Private | 25 | 123 | 1398 | 91 | 7.3 |
| Hospital 5 | Public | 21 | 1006 | 5457 | 81 | 16.5 |
| Hospital 6 | Public | 15 | 299 | 6180 | 90 | 16.5 |

1. §Structure index comprised items from the following domains infrastructure, laboratory services,
2. hygiene equipment, safe delivery equipment and drugs for mothers, resuscitation equipment for
3. newborns in the delivery ward, essential equipment in the newborn unit, IV fluids and feeds in the
4. newborn unit and essential drugs in the newborn unit[24].
5. **¥**Crude inpatient neonatal mortality data estimates are based on study where 21% of the outcome data
6. was missing and are therefore likely to be biased.[26] 464

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Table 2: Characteristics of babies observed

|  |  |
| --- | --- |
| **Characteristic** | **n (%) N=216** |
| **Shift of observation** |  |
| weekday day | 59(27.3) |
| weekday night | 54(25.0) |
| weekend day | 50(23.1) |
| weekend night | 53(24.5) |
| **Neonatal care category** |  |
| A (Severe illness) | 69(31.9) |
| B (Moderate severity) | 75(34.7) |
| C (Stable) | 72(33.3) |
| **Gender** |  |
| Male | 122(56.7) |
| Female | 93(43.3) |
| **Age categories (days)** |  |
| <=2 days | 49(23.0) |
| 3 - 7 days | 80(37.6) |
| 8 - 28 days | 84(39.4) |
| **Pooled birth weight categories** |  |
| <1.4kg | 70(32.6) |
| 1.5-<1.9 | 50(23.3) |
| 2.0-<2.4 | 22(10.2) |
| >=2.5 | 73(34.0) |
| **Nurse : Baby ratio** |  |
| 1 - 3 babies /nurse | 84(39.1) |
| 4 - 11 babies /nurse | 50(23.3) |
| >=12 babies /nurse | 81(37.7) |
| **Type of delivery** |  |
| Spontaneous vaginal delivery | 81(37.9) |
| Caesarean section | 126(58.9) |
| Assisted vaginal delivery | 7(3.3) |
| **Primary diagnosis at observation** |  |
| Premature, LBW | 92(42.6) |
| Respiratory Distress Syndrome | 42(19.4) |
| Jaundice | 24(11.1) |
| Birth asphyxia | 17(7.9) |
| Neonatal sepsis | 9(4.2) |
| Meconium aspiration | 7(3.2) |
| Hypoxic Ischemic Encephalopathy | 5(2.3) |
| For observation/accommodation | 8(3.7) |
| Other | 12(5.6) |

1. Table 3: The number of expected tasks as per neonatal nursing guidelines and the proportion of these tasks completed by domain and type

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Domain** | **Task type** | **Task** | **Required for all babies observed in a 12-**  **hour shift** | **‡Frequency in 24 hours according to standards** | **Number of expected tasks assuming 12-hour observation shifts and adjusting for category / interventions** | **Number of tasks done n (%)** | **95% CI** |
| **Nursing/clinical tasks** | **General nursing** | Handing over nursing  care between shifts | Yes | 2 | 216 | 210(97.2) | 87 - 99 |
| Nursing review of  newborns | Yes | 2 | 216 | 83(38.4) | 16 - 67 |
| Baby cleaned | No | 1 | 126 | 83(65.9) | 43 - 83 |
| Linen changed | No | 1 | 126 | 70(55.6) | 26 - 81 |
| \*Nurse attends ward  round | No | 1 | 75 | 64(85.3) | 21 - 99 |
| Checking and changing  diaper as required | Yes | 8 | 216 | 207(95.8) | 87 - 99 |
| Communication to  parent | Yes | 1 | 216 | 105(48.6) | 30 - 67 |
| €Hand washing/scrub | Yes | 2 | 216 | 200(92.6) | 67 - 99 |
| Cord care where  required | No | 1 | 110 | 42(38.2) | 17 - 65 |
| ¥Temperature  monitored | Yes | 4 | 216 | 127(58.8) | 20 - 89 |
| ¥Respiration monitored | Yes | 4 | 216 | 107(49.5) | 16 - 83 |
| ¥Pulse monitored | Yes | 4 | 216 | 122(56.5) | 19 - 88 |
| ¥Oxygen saturation  monitored | No | 4 | 144 | 49(34.0) | 9 - 72 |
| Turning done as  required | Yes | 8 | 216 | 81(37.5) | 13 - 71 |
| Feeding 3 hourly as  required | No | 8 | 180 | 126(70.0) | 58 - 80 |
| **Phototherapy care** | Clean eyes and check for  discharge/infection | No | 4 | 34 | 12(35.3) | 11-71 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Eye pad changed | No | 2 | 34 | 12(35.3) | 12-69 |
| #Skin assessment | No | 4 |  |  |  |
| Skin assessment 1 |  |  | 34 | 19(55.9) | 27 - 81 |
| Skin assessment 2 |  |  | 34 | 5(14.7) | 1 - 68 |
| #Check eyes for damage  from phototherapy | No | 4 |  |  |  |
| Check eyes for damage 1 |  |  | 34 | 31(91.2) | 53 - 99 |
| Check eyes for damage 2 |  |  | 34 | 19(55.9) | 26 - 82 |
| #Turning/positioning  done | No | 6 |  |  |  |
| Turning/positioning  done 1 |  |  | 34 | 31(91.2) | 48 - 99 |
| Turning/positioning  done 2 |  |  | 34 | 26(76.5) | 48 - 92 |
| Turning/positioning  done 3 |  |  | 32 | 14(43.8) | 23 - 66 |
| **Oxygen therapy care** | Oxygen regulated | No | 8 | 76 | 61(80.3) | 36 - 97 |
| #Check nostril tube  position |  |  |  |
| Check nostril tube  position 1 | 75 | 61(81.3) | 60 - 93 |
| Check nostril tube  position 2 | 76 | 42(55.3) | 17 - 88 |
| Check nostril tube  position 3 | 76 | 42(55.3) | 19 - 87 |
| Check nostril tube  position 4 | 76 | 36(47.4) | 13 - 84 |
| **IV fluids** | §Fluids regulated as  required | No | 2 | 21 | 16(76.2) | 11-99 |
| **IV treatment** | $Cannula flushed before  giving IV treatment | No | 2 | 126 | 51(40.5) | 7 - 86 |
| **KMC** | Counselling and  Supporting mother to | No | 2 | 32 | 29(90.6) | 57 - 99 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | initiate and continue  with KMC | No | 2 | 32 | 24(75.0) | 31 - 95 |
| Supervision of the  mother for correct KMC practice |
| **Documentation tasks** | **Documentation** | Clinical nursing review | Yes | 2 | 216 | 107(49.5) | 22 - 77 |
| Planned care | Yes | 2 | 216 | 140(64.8) | 20 - 93 |
| Vital signs | Yes | 2 | 216 | 154(71.3) | 22 - 96 |
| Treatment documented | No | 2 | 150 | 146(97.3) | 90 - 99 |
| Ward round  recommendations | No | 1 | 75 | 55(73.3) | 44 - 91 |
| Phototherapy  documentation | No | 2 | 31 | 19(61.3) | 18 - 92 |
| Summary of feeds intake | No | 2 | 180 | 137(76.1) | 33 - 95 |
| Oxygen therapy | No | 2 | 76 | 57(75.0) | 43 - 92 |
| ¢Health talks/parent  communications | Yes | 2 | 216 | 53(24.5) | 6 - 63 |
| Charting of fluids  administered | No | 2 | 66 | 60(90.9) | 73 - 97 |
| Turning/positioning | Yes | 2 | 216 | 59(27.3) | 6 - 67 |

1. ¥Monitoring done as per draft neonatal nursing guidelines; #Tasks have multiple sub-items; \*Only one doctors ward round was expected in 24
2. hours; **‡**For instance, for tasks with a frequency of 2 in 24 hours we would observe 1 task in a 12-hour shift; § During the observation shift or
3. when fluid was running, evidence for an attempt to regulate the rate; $For twice daily medication, we would observe 2 tasks in 24 hours
4. €At first contact with patient only since it was difficult to establish a denominator since handwashing should be done before each time the nurse
5. makes contact with the patient; ¢Health talks/parent are supposed to be continuous however we interested in at least two sessions in 24 hours
6. (one during the day and one during the night shift). 478

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Table 4: Mean Nursing Care Index and proportion of babies with adequate nursing care delivered

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mean (SD) Nursing Care Index** | | | **Proportion of babies with adequate nursing care**  **delivered (NCI ≥80%)** |
| **Overall** | **Nursing/clinical tasks** | **Documentation tasks** | **n/N (%)** |
| **Shift of observation** |  |  |  |  |
| weekday day | 61.9 (57.4 - 66.3) | 63.6 (59.4 - 67.9) | 57.5 (49.9 - 65.2) | 9/59 (15.3) |
| weekday night | 58.5 (53.6 - 63.4) | 58.1 (52.4 - 63.9) | 59.3 (54.4 - 64.2) | 6/54 (11.1) |
| weekend day | 62.9 (58.1 - 67.7) | 64.1 (58.9 - 69.4) | 59.9 (53.9 - 65.9) | 7/50 (14.0) |
| weekend night | 58.2 (52.9 - 63.5) | 59.6 (54.0 - 65.3) | 54.5 (48.2 - 60.7) | 9/53 (17.0) |
| **Neonatal care category** |  |  |  |  |
| A (Severe illness) | 63.3 (58.8 - 67.8) | 61.2 (56.3 - 66.0) | 67.8 (62.4 - 73.2) | 16/69 (23.2) |
| B (Moderate severity) | 60.0 (55.8 - 64.3) | 61.6 (56.8 - 66.3) | 55.6 (50.6 - 60.7) | 12/75 (16.0) |
| C (Stable) | 57.9 (54.2 - 61.7) | 61.5 (57.6 - 65.3) | 50.4 (45.1 - 55.6) | 3/72 (4.2) |
| **Nurse: Baby ratio** |  |  |  |  |
| 1 - 3 babies /nurse | 72.9 (69.8 - 75.9) | 73.7 (70.2 - 77.3) | 71.3 (67.4 - 75.1) | 27/84 (32.1) |
| 4 - 11 babies /nurse | 61.1 (57.3 - 64.9) | 62.1 (58.1 - 66.1) | 59.1 (52.8 - 65.3) | 3/50 (6.0) |
| >=12 babies /nurse | 47.0 (43.9 - 50.1) | 48.4 (44.9 - 51.8) | 43.0 (38.5 - 47.4) | 1/81 (1.2) |
| **Sector** |  |  |  |  |
| Mission | 64.8 (61.5 - 68.0) | 65.2 (61.6 - 68.9) | 64.0 (59.7 - 68.2) | 9/72 (12.5) |
| Private | 73.9 (71.2 - 76.6) | 74.6 (71.2 - 78.0) | 72.7 (69.8 - 75.7) | 22/72 (30.6) |
| Public | 42.4 (40.0 - 44.8) | 44.4 (41.3 - 47.4) | 36.6 (31.8 - 41.5) | 0/72 (0.0) |

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Table 5: Univariable and multivariable models for the association of mean NCI with baby and hospital characteristics

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **Model 1 – Univariable associations** | | | | | **Model 2 – Multivariable associations** | | | |
| **Coefficient** | **95% CI** | | **P value** | **R squared** | **Coefficient** | **95% CI** |  | **P value** |
| Gender |  |  |  |  |  |  |  | | | |
|  | Male | Ref |  |  |  | 0.003 |
|  | Female | 1.99 | -2.84 | 6.81 | 0.418 |  |
| Birth weight |  |  |  |  |  |  |  | | | |
|  | <1.4kg | Ref |  |  |  | 0.026 |
|  | 1.5-<1.9 | -7.75 | -14.23 | -1.28 | **0.020** |  |
|  | 2.0-<2.4 | -3.37 | -11.92 | 5.17 | **0.440** |  |
|  | >=2.5 | -3.84 | -9.68 | 2.01 | **0.200** |  |
| Age |  |  |  |  |  |  |  |  |  |  |
|  | <=2 days | Ref |  |  |  | 0.061 | Ref |  |  |  |
|  | 3 - 7 days | -0.16 | -6.34 | 6.02 | 0.959 |  | 1.78 | -3.06 | 6.64 | 0.469 |
|  | 8 - 28 days | 8.82 | 2.70 | 14.95 | 0.005 |  | 7.46 | 2.55 | 12.36 | 0.003 |
| Nursing shift |  |  |  |  |  |  |  | | | |
|  | Day |  |  |  |  | 0.013 |
|  | Night | -4.03 | -8.79 | 0.73 | 0.100 |  |
| Neonatal care category | A (Severe illness) | Ref |  |  |  | 0.015 | Ref |  |  |  |
| B (Moderate severity) | -3.25 | -9.09 | 2.59 | 0.274 |  | -4.27 | -8.78 | 0.23 | 0.063 |
|  | C (Stable) | -5.34 | -11.23 | 0.56 | 0.076 |  | -7.65 | -12.29 | -3.02 | 0.001 |
| Nurse : baby ratio |  |  |  |  |  |  |  |  |  |  |
|  | 1 - 3 babies/nurse | Ref |  |  |  | 0.406 | Ref |  |  |  |
|  | 4 - 11 babies /nurse | -11.79 | -16.65 | -6.92 | <0.001 |  | -11.49 | -16.26 | -6.73 | <0.001 |
|  | >=12 babies /nurse | -25.89 | -30.13 | -21.65 | <0.001 |  | -24.41 | -28.64 | -20.17 | <0.001 |
| Sector |  |  |  |  |  |  |  | | | |
|  | Mission | Ref |  |  |  | 0.556 |
|  | Private | 9.13 | 5.21 | 13.05 | <0.001 |  |
|  | Public | -22.40 | -26.32 | -18.49 | <0.001 |  |

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