Weekend working: A retrospective cohort study of maternal and neonatal outcomes in a large NHS delivery unit

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Condensation

Adopting mandatory 7-day working contracts in the UK National Health Service is unlikely to make any difference to consultant presence during the weekend or to maternal or neonatal morbidity.

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Abstract (260)

Objectives: Mandatory weekend working for NHS consultants is currently the subject of intense political debate. The Secretary of State for Health's proposed 7-day contract policy is based on the claim that such working patterns will improve patient outcomes. We evaluate this claim by taking advantage of as-if-at-random presentation of women for non-elective deliveries throughout the week. We examine (i) whether consultants currently perform fewer deliveries during weekends *versus* weekdays, and (ii) whether adverse outcomes increase during weekends

Study Design: We conducted a retrospective cohort study using data on all non-elective deliveries from January 2008-December 2013 in a large UK obstetrics center (n=27,466). We used Pearson's chi-squared tests to make direct comparisons of adverse outcome rates during weekdays *versus* weekends. Outcomes included: estimated maternal blood loss ≥1.5 litres; severe perineal trauma; delayed neonatal respiration; umbilical arterial pH <7.1; and critical incidents at delivery.

Results: Consultants currently perform the same proportion of non-elective deliveries on weekends and weekdays (2.3% *versus* 2.6%, p = 0.25). We found no increase in any adverse maternal or neonatal outcomes during weekends *versus* weekdays, despite high statistical power to detect such differences. Moreover, adverse outcomes

are no higher during periods of the weekend when consultants are not routinely present compared to equivalent periods during weekdays.

Conclusions: Under current working arrangements, women who would benefit from consultant-led delivery are equally likely to receive one on weekends compared to weekdays. Weekend delivery has no effect on maternal or neonatal morbidity. Adopting mandatory 7-day contracts is unlikely to make any difference to either consultant-led delivery during weekends or to patient outcomes.

Keywords: weekend working; consultants; delivery outcomes; health policy; maternity services

Introduction

Increased risk of adverse events during weekends compared to weekdays in the UK National Health Service (NHS) has long been a concern of doctors, patients, and policy-makers alike (1). This topic recently came into the public spotlight because of remarks made by the Secretary of State for Health, Jeremy Hunt: "Around 6,000 people lose their lives every year because we do not have a proper 7-day service in hospitals" (2). Mr Hunt further argued that requiring mandatory weekend-working contracts for consultants would increase their presence in hospitals during weekends and reduce these additional deaths. These remarks are echoed by current policy recommendations to improve NHS services by reconfiguring consultants' working hours (1).

Yet the presumed causal link between consultant working patterns and higher rates of adverse clinical outcomes is far from clear-cut. We aim to evaluate this link using data on consultants working within maternity services, which are a touchstone for the provision of safe and high-quality care across the NHS (3). Specifically, we examine the risks of adverse outcomes arising from non-elective deliveries in a large UK centre. We compare complication rates during weekdays and weekends to determine (i) whether consultants perform fewer deliveries during weekends than during weekdays, and (ii) whether rates of adverse outcomes increase during weekends.

Previous studies examining rates of neonatal deaths during weekends have demonstrated higher rates outside 09.00-17.00 on weekdays than at other times (4). However, studies specifically comparing weekends to weekdays suggest no differences in neonatal death rates (5-7). Aside from neonatal mortality, there is little

evidence regarding rates of other serious adverse outcomes during weekends compared to weekdays, despite their potentially profound impacts on women and infants.

Our design takes advantage of several important features of obstetric data. First, delivery is a clearly defined, high-risk event at which the presence of a consultant could potentially reduce the risk of adverse outcomes (4). Second, by limiting our focus to non-elective deliveries, our sample is plausibly distributed as-if-at-random between weekend and weekdays, since these women have not chosen when to deliver. This strategy avoids possible selection bias, where the weekend patient population differs from the weekday population in ways that are likely related to the risk of adverse outcomes. Third, the obstetric consultants in our sample have a clear and consistent working pattern throughout the study period, allowing establishment of a reliable link between day and time of delivery and the presence of a consultant.

Methods

32,078 deliveries occurred during a 6-year period (January 2008 - December 2013) in a single large NHS maternity unit in the UK. Elective deliveries were excluded, as they are overwhelmingly more likely to occur during weekdays and carry a substantially lower risk of adverse outcomes. We identified a sub-cohort of 27,466 non-elective deliveries that occurred by spontaneous, instrumental delivery or non-elective Caesarean section for analysis. Inductions of labour were included, as initial analysis determined that these were no more likely to deliver during weekdays than at weekends. Spontaneous vaginal deliveries performed by midwives were also included since senior obstetricians may significantly influence decision-making and

management during these deliveries. We also present results for a second separate sub-cohort of operative deliveries (both instrumental vaginal deliveries and non-elective Caesarean sections, n = 9,010), as the outcomes of these deliveries are the most likely to be directly influenced by the presence of a consultant obstetrician.

In the study centre, 3 doctors are available for emergency work on the delivery unit at any given time. The difference in direct consultant presence on the delivery unit between weekends and weekdays is limited to the hours of 12.00 – 19.00. Outside of these times, the consultant is either present at the same times as during the weekdays (08.00 - 12.00) or is not present at either the weekends or weekdays (19.00 - 08.00). We therefore identified a third sub-cohort of non-elective deliveries that occurred between 12.00 and 19.00 (n = 7,361) to allow separate analysis of outcomes during the time-period when no consultant is directly present during the weekends, but would have been on a weekday. No consultant opted out of weekend duty during the study period.

Study data were obtained from an electronic maternity data-recording system, which is updated by midwives shortly after delivery. The database is regularly validated by a rolling program of audits, where the original case notes are checked against the information recorded. No patient-identifiable data were accessed in the course of this research, which was performed as part of a provision-of-service study for the obstetrics centre. Individual medical records were not accessed at any stage, and the study was therefore deemed exempt from full institutional review board approval.

Data obtained on delivery characteristics included maternal age in years (at time of delivery), BMI (measured at first trimester prenatal booking), parity (prior to delivery), and the birth-weight of the infant (recorded to the nearest gram). Gestational age was determined from first trimester ultrasound and recorded to the nearest week. Deliveries were classified as either spontaneous onset or induced. The healthcare professional delivering the baby was either a midwife or a doctor classified by years of specific obstetric training at the time of the delivery. Categories of experience were: ≤2 years (including those in the second year of foundation training, vocational general practitioner training, or the first 2 years of specialty training); 3-5 years (including both doctors in years 3-5 inclusive of their specialty training and those of equivalent experience not enrolled in a specialty training programme); >5 years (doctors in years 6/7 of the specialty training programme or those of equivalent or greater experience not employed as NHS consultants); and consultants (all of whom must have a minimum of 7 years obstetric training). Delivery type was classified as elective Caesarean section, emergency Caesarean section, instrumental delivery (sub-classified as forceps or ventouse) and vaginal deliveries (sub-classified as either breech or cephalic). Elective Caesarean deliveries were excluded from the analysis.

Outcome data on maternal and neonatal complications were obtained from the same database. Delay in neonatal respiration was defined as no spontaneous neonatal respiration within 1 minute of delivery. Where the healthcare professional performing delivery deemed it necessary (typically all non-elective operative deliveries and those involving concern about neonatal well-being before delivery or at birth), the pH of umbilical arterial blood was tested immediately following delivery. Umbilical arterial

158 pH was categorized as ≥7.1 or <7.1 (8). A critical-incident form was generated at
159 delivery in the case of any obstetric or neonatal emergency, including maternal death,
160 full neonatal resuscitation, shoulder dystocia, maternal visceral injury or any other
161 event triggering an obstetric emergency call. Maternal blood loss was estimated as
162 soon as possible after delivery. Estimated blood loss was categorized as <1.5 litres or
163 ≥1.5 litres. Severe maternal perineal trauma was defined as any third or fourth degree
164 tear.
165
166 Standard significance tests were used to assess whether patients delivering at the
167 weekend *versus* weekdays exhibited any imbalances in risk factors for adverse
168 neonatal and maternal outcomes. A two-sided, two-sample t-test with unequal sample
169 sizes was used for each continuous numerical risk factor (maternal age, maternal
170 BMI, gestational age, and birth weight). A Pearson chi-squared test was used for each
171 categorical risk factor (parity, race of the mother, delivery type, induction of labor,
172 and the delivering healthcare professional).
173
174 All five adverse outcomes analysed are binary events. Complication rates on
175 weekends versus weekdays were compared using two-sample tests of proportions
176 with unequal sample sizes. For each outcome, a one-sided test was conducted, in
177 which the alternative hypothesis is that the adverse-outcome rate is higher on the
178 weekend than on the weekday. Compared with a two-sided test, this allowed greater
179 power to detect excess complications for weekend deliveries.
180
181 Power calculations were performed for all comparisons of adverse-outcome rates.
182 For each test, the minimum detectable effect size was calculated: that is, the smallest

effect size (Δ) that could be detected at a significance level of 0.05 with power of at least 80%. These effect sizes are expressed as an absolute difference in rates (e.g. 4.9% on weekends versus 4.8% on weekdays is a $\Delta = 0.1\%$ effect size). These power calculations were initially performed using the standard Gaussian approximation to the binomial test but were also verified using Monte Carlo simulation. The Monte Carlo simulations showed slightly lower power than the Gaussian approximation. In our results, we therefore quote the more conservative numbers from the Monte Carlo simulations. Based on our findings of no statistically significant differences in any adverse outcomes between deliveries during weekends and weekdays, no corrections for multiplicity in our assessments of statistical significance were required. Correcting these p-values for multiplicity could only make them appear less significant, meaning that would be impossible for such a correction to materially change our findings.

All data analyses were conducted using the R statistical software package version 3.2.0 (9). Findings were considered statistically significant at an alpha level of 0.05. An R script containing code for all adverse-outcome comparisons and power calculations is available as a supplemental file.

Results

There were no significant differences in the maternal, neonatal or delivery-related characteristics for non-elective deliveries occurring on weekdays (n =19,626) compared to those occurring at weekends (n= 7,840) (Table 1) and no difference in the total number of non-elective deliveries that occurred on any day. This finding suggests that cases of broadly similar clinical difficulty present during weekdays and

weekends and that comparisons of complication rates are not prone to any obvious source of confounding. There were no differences in the rates of any adverse outcomes for non-elective deliveries that occurred during the weekdays compared to the weekends (Table 2). Our power calculations demonstrate that for all non-elective deliveries, the minimum detectable effect sizes range from 0.5% (for estimated blood loss) to 1.2% (for arterial umbilical pH < 7.1). These minimum detectable effect sizes can be interpreted as a likely upper bound on the magnitude of any discrepancy between the weekend and weekday rates. When non-elective operative deliveries performed by doctors only were considered (n=9,010), none of the rates of adverse outcomes at weekends were significantly different from those occurring during the weekdays (Table 2). In this sub-cohort, the minimum detectable effect sizes range from 1.1% (for estimated blood loss) to 1.8% (for delayed neonatal respiration).

Deliveries were equally likely to be performed by consultants at weekends as during the weekdays: 508/19,626 (2.3%) *v.* 184/7,840 (2.6%), p=0.25. The characteristics of mothers, neonates and deliveries were not significantly different during afternoons during weekdays (when consultants were routinely present) compared to weekends (when consultants were not routinely present) (Table 3). There was no increase in the rates of any adverse outcomes during the afternoon period at weekends, compared to during weekdays (Table 4). The minimum detectable effect sizes for this analysis range from 1.0% (for estimated blood loss) to 2.5% (for low arterial umbilical pH).

Discussion

We present evidence that serious adverse delivery events within NHS maternity services are not increased at the weekend compared to weekdays. The study cohort is

well powered for all outcomes examined and allows direct comparison of outcomes during consultant presence with times when no consultant was present. No differences were found in any of the adverse outcomes studied, either in all non-elective deliveries or in those undergoing non-elective operative delivery. Moreover, despite consultants being routinely present on the delivery unit for fewer hours at weekends, the proportion of babies delivered by consultants did not decrease at the weekends. Specific examination of the period when consultants would be additionally present if their working patterns were identical during weekdays and weekends (12.00-19.00 on Saturday and Sunday) revealed no increase in the rates of any adverse outcomes.

Our results accord with those from a large, recent North American cohort, which reported no increase in rates of pelvic morbidity (including perineal trauma as defined here) or other severe maternal morbidity on weekends when compared to weekdays (10). By contrast, a recent UK study found that there was an increase in perinatal mortality and maternal infection on weekend days (11). This study took the unusual step of comparing weekend days to those deliveries occurring on Tuesdays only, rather than a comparison over all weekdays. Furthermore, all stillbirths (including those where the death occurred antepartum) were attributed to the day of delivery. These methodological steps may account for the differences in the detection of a 'weekend effect' in the previous study, although none is present in our cohort. However, direct comparisons between studies are precluded by the differences in outcomes assessed.

Our study has several important limitations. The study was not powered to detect an increase in maternal mortality or to consider neonatal mortality, except within the

composite outcome of 'critical incidents'. Other studies, however, suggest that neonatal deaths may not be significantly increased during weekends (5-7), although they are higher outside of 09.00-17.00 weekdays than at other times (4). Maternal death rates in the UK are as low as 1/10,000 (12). Although neonatal deaths are more common, with a perinatal extended death rate at 6/1,000, this figure includes antepartum stillbirths, which would not be affected by weekend consultant working patterns (13). While our conclusions are applicable only to non-elective deliveries, elective deliveries account for only a small proportion of all deliveries in the UK and are not routinely scheduled over weekends, thus precluding weekday versus weekend comparisons.

A further limitation of our study is that data from a single site may not be generalizable to other dissimilar populations. However, the characteristics of our population (including maternal age, birth weight and mode of delivery) are similar to those of maternity service users elsewhere in England (14), implying that our results are likely applicable to a high proportion of maternity services. Indeed, one advantage of a single site design is that it ensures detailed reporting of serious adverse events other than mortality, which are less well captured in other cohorts. While our study is focused exclusively on outcomes from maternity services and thus is of particular relevance to obstetricians, we suggest that delivery outcome data represent a good model for the multitude of high-risk emergency services that the NHS provides to the general population on a short-term basis.

Consultant involvement in care is certainly important in reducing adverse outcomes both within obstetric services across the NHS overall (15). However, we find no

283 evidence in support of a causal link between consultant contractual obligations and
284 higher rates of adverse clinical outcomes. Across the NHS as a whole, mortality rates
285 for patients admitted during the weekend are higher than for those admitted during the
286 week (16, 17), and similar trends have been observed among patients presenting for
287 acute emergency care (18). But, the weekend patient population in most specialties
288 differs from the weekday population in ways that are likely related to the risk of
289 adverse outcomes—for example, major trauma is most likely to occur on Saturday
290 night (19). While some evidence suggests that increased consultant presence could
291 reduce the weekend fatality rate for acute medical inpatients (20), other evidence
292 bears out the selection-bias hypothesis: among non-acute-emergency patients, the
293 association between weekend admission and increased mortality does not hold true
294 for all conditions (21, 22), and it is stronger for conditions with higher baseline
295 mortality rates (22, 23). Our study also highlights the importance of considering
296 adverse outcomes other than mortality. Although overall mortality within 30 days
297 after emergency admission for high-risk conditions in England is 5.59% (24), a high
298 proportion of patients seeking non-elective weekend care in the NHS do so for
299 conditions with very low baseline rates of mortality, including the users of maternity
300 services.
301
302 In contrast to the current policy change proposed by the Secretary of State for Health,
303 our findings imply that mandatory '7-day working' by consultants is unlikely to have
304 an impact on the rates of common adverse outcomes in maternity care. Within the
305 current system, consultants appear to be readily available for deliveries if and when
306 required. In light of multiple competing demands on NHS finances (25), restructuring

working patterns to mandate continuous consultant presence at weekends is unlikely to be either an effective or efficient use of resources to improve patient care.

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Disclosures of Interest

The authors have no conflicts of interest to declare.

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Table legends

Table 1: Characteristics of non-elective deliveries occurring in the study centre (January 2008 - December 2013), by delivery during weekdays or weekends. P values represent the results of comparison of means via Student's t-test (2-tailed, unequal

406 sample size) for continuous variables, and Pearson's chi-squared (2-tailed, unequal
407 sample size) for categorical variables.
408
409 Table 2: Adverse outcomes by delivery during weekdays or weekends. Percentages
410 represent the percentage experiencing the adverse outcome from all deliveries where
411 outcome data were available. P values are calculated using one-tailed Pearson's chi-
412 squared. Δ is the smallest effect size that could be detected at a significance level of
413 0.05 with power of at least 80%.
414
415 Table 3: Characteristics of non-elective deliveries occurring during 12.00 – 19.00 in
416 the study centre (January 2008 - December 2013), by delivery during weekdays or
417 weekends. P values represent the results of comparison of means via Student's t-test
418 (2-tailed, unequal sample size) for continuous variables, and Pearson's chi-squared
419 (2-tailed, unequal sample size) for categorical variables.
420
421 Table 4: Adverse outcomes by delivery during weekdays or weekends, for non-
422 elective deliveries occurring between 12.00 and 19.00. Percentages represent the
423 percentage experiencing the adverse outcome from all deliveries where outcome data
424 were available. P values are calculated using one-tailed Pearson's chi-squared. Δ is
425 the smallest effect size that could be detected at a significance level of 0.05 with
426 power of at least 80%.