

18 **Condensation**

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

22

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

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28

29 **Abstract (260)**

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

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

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

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

49 **Conclusions:** Under current working arrangements, women who would benefit from
50 consultant-led delivery are equally likely to receive one on weekends compared to
51 weekdays. Weekend delivery has no effect on maternal or neonatal morbidity.

52 Adopting mandatory 7-day contracts is unlikely to make any difference to either
53 consultant-led delivery during weekends or to patient outcomes.

54

55 **Keywords:** weekend working; consultants; delivery outcomes; health policy;

56 maternity services

57

58

59 **Introduction**

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

70

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

79

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

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

87

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

98

99 **Methods**

100 32,078 deliveries occurred during a 6-year period (January 2008 - December 2013) in
101 a single large NHS maternity unit in the UK. Elective deliveries were excluded, as
102 they are overwhelmingly more likely to occur during weekdays and carry a
103 substantially lower risk of adverse outcomes. We identified a sub-cohort of 27,466
104 non-elective deliveries that occurred by spontaneous, instrumental delivery or non-
105 elective Caesarean section for analysis. Inductions of labour were included, as initial
106 analysis determined that these were no more likely to deliver during weekdays than at
107 weekends. Spontaneous vaginal deliveries performed by midwives were also included
108 since senior obstetricians may significantly influence decision-making and

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

113

114 In the study centre, 3 doctors are available for emergency work on the delivery unit at
115 any given time. The difference in direct consultant presence on the delivery unit
116 between weekends and weekdays is limited to the hours of 12.00 – 19.00. Outside of
117 these times, the consultant is either present at the same times as during the weekdays
118 (08.00 - 12.00) or is not present at either the weekends or weekdays (19.00 - 08.00).

119 We therefore identified a third sub-cohort of non-elective deliveries that occurred
120 between 12.00 and 19.00 (n = 7,361) to allow separate analysis of outcomes during
121 the time-period when no consultant is directly present during the weekends, but would
122 have been on a weekday. No consultant opted out of weekend duty during the study
123 period.

124

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

132

133 Data obtained on delivery characteristics included maternal age in years (at time of
134 delivery), BMI (measured at first trimester prenatal booking), parity (prior to
135 delivery), and the birth-weight of the infant (recorded to the nearest gram).

136 Gestational age was determined from first trimester ultrasound and recorded to the
137 nearest week. Deliveries were classified as either spontaneous onset or induced. The
138 healthcare professional delivering the baby was either a midwife or a doctor classified
139 by years of specific obstetric training at the time of the delivery. Categories of
140 experience were: ≤ 2 years (including those in the second year of foundation training,
141 vocational general practitioner training, or the first 2 years of specialty training); 3-5
142 years (including both doctors in years 3-5 inclusive of their specialty training and
143 those of equivalent experience not enrolled in a specialty training programme); >5
144 years (doctors in years 6/7 of the specialty training programme or those of equivalent
145 or greater experience not employed as NHS consultants); and consultants (all of
146 whom must have a minimum of 7 years obstetric training). Delivery type was
147 classified as elective Caesarean section, emergency Caesarean section, instrumental
148 delivery (sub-classified as forceps or ventouse) and vaginal deliveries (sub-classified
149 as either breech or cephalic). Elective Caesarean deliveries were excluded from the
150 analysis.

151

152 Outcome data on maternal and neonatal complications were obtained from the same
153 database. Delay in neonatal respiration was defined as no spontaneous neonatal
154 respiration within 1 minute of delivery. Where the healthcare professional performing
155 delivery deemed it necessary (typically all non-elective operative deliveries and those
156 involving concern about neonatal well-being before delivery or at birth), the pH of
157 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

183 effect size (Δ) that could be detected at a significance level of 0.05 with power of at
184 least 80%. These effect sizes are expressed as an absolute difference in rates (e.g.
185 4.9% on weekends versus 4.8% on weekdays is a $\Delta = 0.1\%$ effect size). These
186 power calculations were initially performed using the standard Gaussian
187 approximation to the binomial test but were also verified using Monte Carlo
188 simulation. The Monte Carlo simulations showed slightly lower power than the
189 Gaussian approximation. In our results, we therefore quote the more conservative
190 numbers from the Monte Carlo simulations. Based on our findings of no statistically
191 significant differences in any adverse outcomes between deliveries during weekends
192 and weekdays, no corrections for multiplicity in our assessments of statistical
193 significance were required. Correcting these p-values for multiplicity could only make
194 them appear less significant, meaning that would be impossible for such a correction
195 to materially change our findings.

196

197 All data analyses were conducted using the R statistical software package version
198 3.2.0 (9). Findings were considered statistically significant at an alpha level of 0.05.
199 An R script containing code for all adverse-outcome comparisons and power
200 calculations is available as a supplemental file.

201

202 **Results**

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

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

220

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

229

230 **Discussion**

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

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

242

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

255

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

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

268

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

280

281 Consultant involvement in care is certainly important in reducing adverse outcomes
282 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

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

309

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317

318 **Disclosures of Interest**

319 The authors have no conflicts of interest to declare.

320

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401

402 Table legends

403 Table 1: Characteristics of non-elective deliveries occurring in the study centre
404 (January 2008 - December 2013), by delivery during weekdays or weekends. P values
405 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%.