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A retrospective study of seven-day consultant working: reductions in mortality and length of stay

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ABSTRACT Weekend admission is associated with higher in-hospital mortality than weekday admission. Whether providing enhanced weekend staffing for acute medical inpatient services reduces mortality or length of stay is unknown
Methods This paper describes a retrospective analysis of in-hospital mortality and length of stay before and after introduction of an enhanced, consultant-led weekend service in acute medicine in November 2012. In-hospital mortality was compared for matching admission calendar months before and after introduction of the new service, adjusted for case volume. Length of stay and 30-day post-discharge mortality were also compared; illness severity of patients admitted was assessed by cross-sectional acuity audits.
Results Admission numbers increased from 6,304 (November 2011–July 2012) to 7,382 (November 2012–July 2013), with no change in acuity score in elderly medical patients but a small fall in younger patients. At the same time, however, a 57% increase in early-warning score triggered calls was seen in 2013 (410 calls vs 262 calls in 2012; p<0.01). Seven-day consultant working was associated with a reduction in in-hospital mortality from 11.4% to 8.8% (p<0.001). Mortality within 30 days of discharge fell from 2.4% to 2.0% (p=0.12). Length of stay fell by 1.9 days (95% CI 1.1–2.7; p=0.004) for elderly medicine wards and by 1.7 days (95% CI 0.8–2.6; p=0.008) for medical wards. Weekend discharges increased from general medical wards (from 13.6% to 18.8%, p<0.001) but did not increase from elderly medicine wards.
Conclusions Introduction of an enhanced, consultant-led model of working at weekends was associated with reduced in-hospital and 30-day post discharge mortality rates as well as reduced length of stay. These results require confirmation in rigorously designed prospective studies.

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INTRODUCTION

Emergency hospital admissions in the UK are estimated to cost the NHS £11 billion a year.[1] Furthermore it is known that mortality rates for patients admitted at weekends are higher than for patients admitted during the week.[2,3] Controversy exists as to whether this is due to weekend admissions having more severe illnesses, or due to reduced access to senior and junior medical staff, or due to reduced access to diagnostics and support staff.

In 2011, the Dr Foster Guide indicated that weekend mortality rates were lower when there was a greater presence of senior medical staff.[4] Evidence to inform the debate is very scant; there have been very few attempts to analyse the impact of changing models of weekend care on either mortality or length of stay. To try and improve the delivery of care to patients at the weekend, we developed an enhanced seven-day working system in our Medical Division to ensure there was a consultant presence from all the medical specialities at weekends. Previously our working model had focused on reviews within 24 hours of all acute admissions but with no routine review of patients already admitted during the week; no specialist service was normally delivered at weekends.

The aim of this paper is to analyse the impact of this enhanced seven-day working model on patients admitted non-electively to the Medical Division, by comparing length of stay and mortality of patients admitted before and after implementation of the new model.

METHODS

Intervention package

Wirral University Teaching Hospital (WUTH) commenced enhanced seven-day working for all medical

specialities in November 2012. This was a major change in working practices across the Medical Division and also across other divisions. Enhanced seven-day working included the following specialities: diabetes, respiratory, gastroenterology, cardiology, elderly care, nephrology and stroke.

Discussions were held with consultants, allied healthcare professionals, nurses and the Diagnostic Division to enable changes to working practices. This required a significant increase in investment resulting in an increase in consultant staff with compensatory leave provided to offset the additional time involved in weekend working. The increase in consultant numbers varied across departments and specialties in order to provide a 1 in 7 rota. Consultants spent 4.5–6 hours per weekend day on average on the wards. The gastroenterology consultant also performed routine endoscopy lists and cardiologists reviewed all coronary care and cardiac unit patients. In addition to the routine duty endoscopy list, all the gastroenterologists participated in a gastrointestinal bleeding rota. The development of a sustainable seven-day weekend rota has resulted in a 1 in 5 to 1 in 8 on-call rota frequency for the various specialities.

The number of junior doctors was also increased to ensure there was a junior doctor with each consultant-led speciality ward round. This meant that the junior doctor had increased exposure to patients in that speciality and allowed closer consultant supervision and feedback. The additional number of junior trainees was small (3–4 individuals) and consisted primarily of Trust grade F2 appointments. This was not associated with a reduction in weekday working by trainees. Three to four Advanced Nurse Practitioners were also appointed and trained to provide additional ward cover. No additional support was required from chemical pathology or pharmacy (a weekend pharmacy service was already in place) but additional radiology input was provided to allow an increase in radiological investigations. No increase in weekend social work or in the existing supported discharge service was provided.

The process required nursing staff to identify patients requiring weekend review in order to address medical concerns or to enhance the discharge process. One additional Nurse Practitioner was recruited to assist with weekend cover.

Analysis of intervention effect

We examined admissions and discharges in the ten wards that were affected by seven-day working in the Medical Division. These included four Department of Medicine for the Elderly (DME – patients aged 74 years or more) wards and six medical wards. Admissions and discharges to these wards from November 2012–July 2013 at the weekends (defined as an admission from midnight on Friday/Saturday to midnight on Sunday/Monday) and Monday to Friday were analysed. We also examined the length of stay, crude in-patient mortality in these wards and the 30-day mortality post discharge from the hospital; all data were collected from the hospital patient administration system (Cerner Inc). These data were compared to the same time period the previous year at a time when only acute admissions were routinely reviewed at weekends (November 2011–July 2012). Acuity of patients was assessed by using an acuity tool developed by the Association of UK University Hospitals as applied during cross-sectional audits in the periods studied. This tool classifies the level of illness severity or complexity and level of support and care needed, adapted for use across a range of specialties. Reviews arising from high Medical Early Warning Scores (MEWS) were also counted to assess the case mix and acuity of patients during these timeframes.

Statistical methods

All analyses were based on paired observations using data from corresponding pairs of months in the periods before and after the adoption of seven-day working. Parametric regression analysis was conducted assuming the number of deaths in a given month is Poisson distributed with an unknown rate per number of admissions, with the rate assumed to be different in every month, but a common rate ratio between pairs of months. This rate ratio can be estimated by conditioning on the total number of deaths in each pair of months and employing methods for binomial generalised linear models with appropriate offsets based on the number of admissions in each month. Separate ward type and weekend versus weekday effects can be incorporated by including these as explanatory factors within the regression. Analysis of the number of deaths following discharge can be carried out using the same methods but using number of discharges as the denominator. The Poisson assumption was tested using chi-squared test of observed and expected number of deaths in each pair of months given the observed number of admissions.

In addition non-parametric, two-sided binomial sign tests based on the number of pairs of months for which the estimate rate of deaths

$$\lambda_{\iota\kappa} = \frac{\gamma_{\iota\kappa}}{\eta_{\iota\kappa}}$$

where $\gamma_{\iota\kappa}$ is the number of deaths in month ι in year κ and $\eta_{\iota\kappa}$ is the number of admissions, is lower in the month after the introduction of seven-day working, are also used to test for a significant change in mortality rates. A sign test was also used to test differences in the proportion of weekend discharges based on the number of pairs of months for which the proportion was lower in the month after the introduction of seven-day working.

Change in mean length of stay for DME and medical wards was tested using a Wilcoxon-signed-rank test for pairs of months in the periods before and after the

TABLE 1 Total number of admissions, discharges, crude mortality and 30-day mortality for the periods examined and the number of deaths expressed as a percentage of the total number of admissions or discharges

All wards	**November 2011–July 2012**	**November 2012–July 2013**
Deaths (%)	722 (11.4)	646 (8.8)
Admissions	6,304	7,382
Deaths within 30 days of discharge (%)	161 (2.4)	158 (2.0)
Total discharges	6,783	7,892
Weekend discharges (%)	977 (14.4)	1361 (17.2)
DME wards	**November 2011–July 2012**	**November 2012–July 2013**
Deaths (%)	417 (14.3)	331 (11.0)
Admissions	2,916	3,001
Deaths within 30 days of discharge (%)	80 (2.9)	69 (2.2)
Total discharges	2,787	3,020
Weekend discharges (%)	435 (15.6)	469 (15.5)
Medical wards	**November 2011–July 2012**	**November 2012–July 2013**
Deaths (%)	305 (9.0)	315 (7.2)
Admissions	3,388	4,381*
Deaths within 30 days of discharge (%)	81 (2.0)	89 (1.8)
Total discharges	3,996	4,872
Weekend discharges (%)	542 (13.6)	892 (18.3)

*p<0.001. Note that transfers from non-medical specialties to medical wards are counted in discharges, but not in admissions

TABLE 2 Mortality rate ratio estimates for post seven-day working compared to pre seven-day working (November 2011–July 2012)

	Adjusted in-hospital mortality		**Adjusted 30 day post-discharge mortality**	
	Estimated rate ratio (95% CI)	**p**	**Estimated rate ratio (95% CI)**	**p**
All wards and admissions	0.79 (0.71,0.88)	<0.001	0.84 (0.67, 1.05)	0.12
DME	0.78 (0.68, 0.90)	<0.001	0.80 (0.58, 1.10)	0.17
Medical	0.81 (0.69, 0.94)	0.008	0.88 (0.65, 1.19)	0.42
DME (weekday)	0.79 (0.67, 0.92)	0.003	0.78 (0.56, 1.09)	0.15
Medical (weekday)	0.82 (0.69, 0.97)	0.019	0.86 (0.62, 1.19)	0.36
DME (weekend)	0.76 (0.60, 0.96)	0.020	0.88 (0.64, 1.22)	0.66
Medical (weekend)	0.78 (0.61, 0.99)	0.045	0.97 (0.57, 1.68)	0.93

adoption of seven-day working. A separate analysis based on the average length of stay of only patients admitted on weekends was also conducted.

Standard errors and p-values were calculated using bootstrap resampling which is robust to over-dispersion. All computations were performed using the R statistical software version 3.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Mortality rates

Table 1 shows the overall number of admissions, discharges, and deaths during the admission, and in the 30 days post discharge for all wards examined. The number of admissions to DME wards in the period after seven-day working was comparable with the period prior to starting the intervention. In contrast, the number of admissions to medical wards was 29% higher in the period after starting the intervention. Overall numbers of admissions were lower than discharges as some patients were classified as having been admitted to other departments and then transferred to Medicine.

Figure 1 shows the month to month changes in admission and deaths in the periods studied. In the medical wards, admissions were higher in each of the months from November 2012–July 2013 compared to the same period a year before. In the DME wards, the number of deaths was lower in each of the months from November 2012–July 2013, apart from one month compared to the same period a year before. There were significant reductions in crude mortality in all wards in the 9 months following the introduction of seven-day

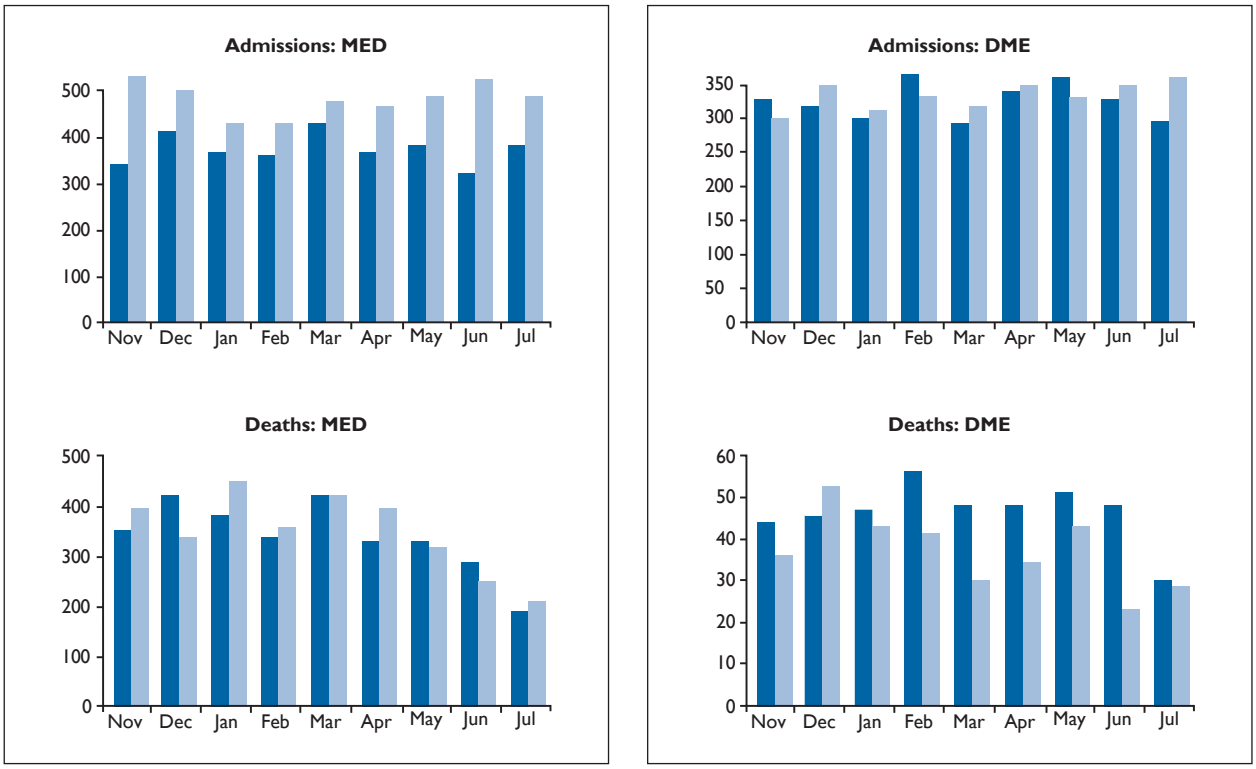

FIGURE 1 Total number of admissions and deaths for Nov 2011–July 2012 (dark blue) and Nov 2012–July 2013 (light blue) in medical and DME wards

working (Table 2) and this was irrespective of the day of admission. Figure 2 shows the mortality rates in the DME and medical wards per month. The two-sided p value for the sign test was 0.039. Extra Poisson variability was seen in the September versus September pattern of deaths. However the non-parametric sign test remained significant.

The number of patients dying within 30 days of discharge was 16% lower in the period after seven-day working commenced compared to the same months a year before (Table 2). However, the effect was not statistically significant (p=0.12), partly because of the low number of deaths within 30 days. A slightly greater improvement in the proportion of patients surviving was observed for DME wards compared to medical wards (20.3% reduction in deaths for DME compared to 11.8% reduction for medical). However, this difference was not statistically significant (p=0.65). Similarly, the reduction in death rates was lower in weekend discharges than weekday discharges, but no statistically significant difference was observed (p=0.66).

Across all wards there was an increase in the percentage of discharges occurring at the weekend after the implementation of seven-day working (Table 1). However, the increase was entirely due to an increase in the proportion of weekend discharges in medical wards, where the number of weekend discharges increased from 13.6% to 18.3% (p<0.001). In contrast there was no change in the proportion of weekend discharges for DME wards: 15.5% compared to 15.6% (p=0.91). The total number of discharges for both DME and medical wards was also higher in the period from November 2012–July 2013 compared to the preceding period.

Length of stay

Following implementation of seven-day working, the mean length of stay for DME wards from November 2012–July 2013 was lower than in the corresponding period in 2011/2012 (11.4 vs 13.3 days; mean difference 1.9 days [95% CI 1.1–2.7]; p=0.004). Similarly, mean length of stay for medical wards was also lower during the intervention period (7.5 vs 9.2 days; mean difference 1.7 days [95% CI 0.8–2.6]; p=0.008).

There was a similar reduction in length of stay for patients admitted over the weekend (DME patients: 1.4 days [95% CI -1.0–3.8], p=0.25; medical patients 1.6 days [95% CI 0.0–3.2], p=0.10) but this did not reach significance due to smaller numbers in the analysis.

Changes in illness severity and other indicators of care

We also assessed the acuity of patients admitted during this time period using an acuity tool audit. Data were analysed using the Wilcoxon test. These data showed significant variability in acuity for different wards and time periods. No evidence was seen of a consistent reduction in acuity in 2013 following the introduction of seven-day working. Acuity in the DME wards was unchanged (mean acuity scores for DME wards were

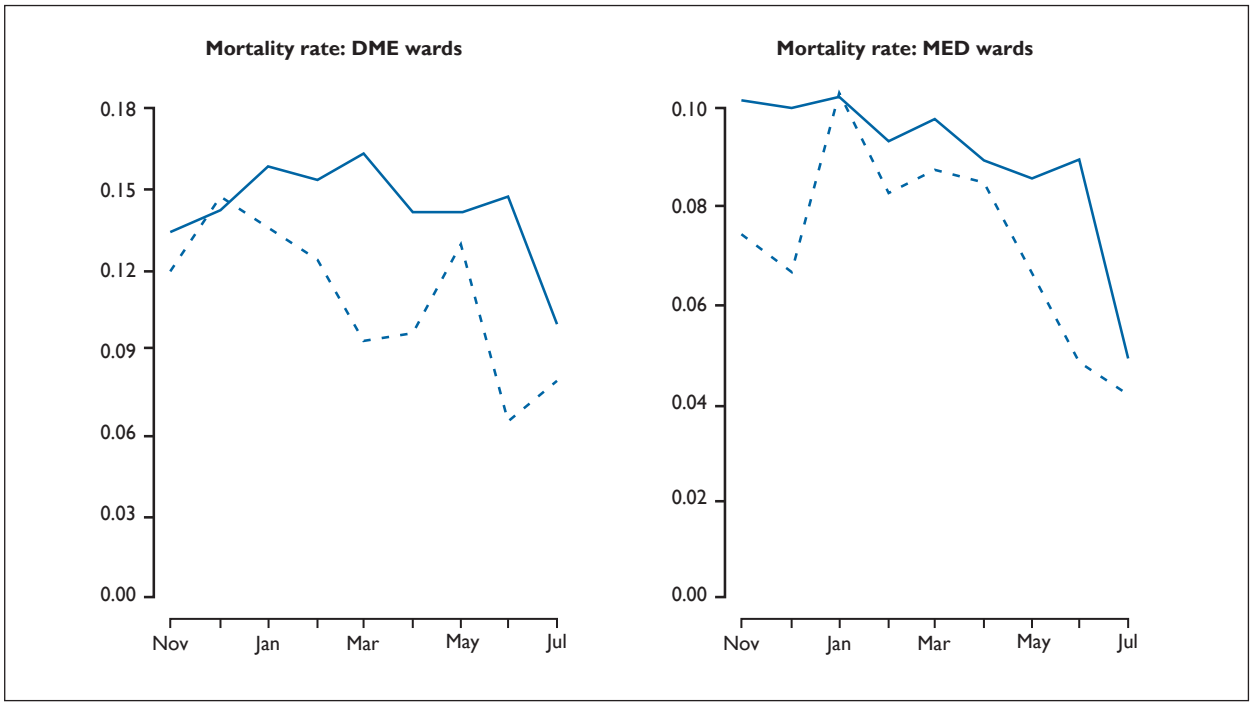

FIGURE 2 Mortality rates for DME and medical wards for Nov 2011–Jul 2012 (solid line) and Nov 2012–July 2013 (dashed line)

44.2 in 2011, and 44.6 in 2013), while a small reduction in acuity on the medical wards was observed (mean scores 53.8 in 2011 and 41.3 in 2013; $p<0.01$). However the number of MEWS calls in which urgent assessment of ward patients with MEWS scores of >2 occurred increased by 57% in 2013 (410 calls), compared to 2012 (262 calls) ($p<0.001$) suggesting that a higher number of more seriously ill patients were admitted during the second study period.

DISCUSSION

The significant increase in discharges over the weekend from the medical wards occurred at a time when a 17% increase in admissions was seen over the period studied following the start of seven-day working. Reductions in mortality in our medical and elderly care patients were also demonstrated. Reassuringly, there has not been an increase in 30-day mortality for discharged patients. Although there was a 16% reduction in 30-day mortality, this was not statistically significant. This is an important finding as it suggests that the reduction in length of stay following enhanced seven-day working does not result in patients being discharged inappropriately. We consider it is unlikely that these findings are explained by increased numbers of less acute admissions, as the audits of illness acuity in medicine and DME did not demonstrate significant changes in acuity between the before and after seven-day working time periods. Furthermore the number of MEWS calls increased significantly in 2013, suggesting there was an increase in seriously ill patients admitted during that time. If the change in mortality was primarily due to reduced acuity we would not have anticipated a rise in MEWS calls which suggests that, while overall numbers of patients increased, the number of acutely ill patients also increased.

The literature in this field includes evidence of greater mortality for those admitted at the weekend and within the following 30 days.[5,6] Similar observations are seen for patients with differing conditions including acute kidney injury and also following elective surgical admissions.[7,8] Previous work has examined the role of consultant input into acute medical admissions using a validated contemporaneous survey and hospital episode statistics. Consultant presence for at least 4 hours per day was associated with a lower adjusted case fatality rate.[9] Ahmed and colleagues have also described a reduction in length of stay as a result of twice daily ward rounds in general medical wards.[10] Similar findings were seen for time to coronary artery intervention but not for thrombolysis.[11] However other studies have found that patients admitted to intensive care units at night or at weekends had no such reduction in mortality. This is likely to reflect the additional supervision and resource available to ITU patients.[12]

Weekend admission to hospitals in the USA is also associated with higher risk adjusted mortality but those patients admitted to a 'Teaching Hospital' also had slightly higher mortality; factors other than physician availability may be responsible.[13] Imison reports that busier hospitals have been found to have lower mortality rates but repeats the view that there remains a lack of high quality data on which, currently, to guide reconfiguration of hospital services.[14] The statistical information obtained from hospitals has also been criticised as being unable to provide clear

information on the quality of care provided.[15] Even case mix adjusted hospital mortality may not be a reliable indicator of avoidable mortality.[16] Others have raised similar concerns over the validity of hospital standardised mortality ratios.[17]

The major principle of seven-day working is to ensure that patients have effective and timely access to specialist care, as indicated in the Future Hospital Commission report.[18] The implementation of enhanced seven-day working at our hospital has seen a major shift in working practices for consultants. Since the completion of this pilot study other allied healthcare professionals now provide enhanced weekend working. This has meant the focus on treatment and rehabilitation of patients does not stop at weekends. There have also been significant changes in working practices for the diagnostic services to enable timely investigations to be carried out at the weekend, thereby accelerating time to diagnosis.

Seven-day working has enabled patients to be reviewed by a specialist consultant at the weekend as well as during routine weekday hours thereby allowing rapid and appropriate decisions to be made. Previously, patients may not have been reviewed over a weekend by a specialist consultant and a delay in decision-making may have affected their care. Seven-day working has brought forward senior review of acutely ill and recovering patients to seven days a week and accelerated appropriate care by 24–48 hours resulting in an overall reduction in length of stay. In addition to reviewing patients admitted on-call, seven-day working also includes reviewing non acute patients and patients suitable for discharge. Consultants visit all wards at weekends and the wards identify these patients for the consultants to review.

There has been an increase in numbers of consultant staff to enable seven-day working at weekends and to ensure the compensatory time back from weekend working does not adversely affect routine activity. Significant increases in consultant staff have been seen in some specialities. This model therefore may not be practical in all secondary care trusts and may require reconfiguration of services if it can be clearly demonstrated that seven-day working has the effects indicated but not proven in this study. The increased number of junior doctors also meant that the junior doctor has increased exposure to patients in that speciality and allowed closer consultant supervision and feedback.

We are not aware of any additional factors which could have influenced these outcomes during the time of the observations. However, MEWS call outs increased during this time, suggesting there had not been a fall in the numbers of seriously ill patients, although patient dependency as measured by the acuity tool was lower in the second study period, at least in general medical patients. However, we remain aware of the limitations of this study as external factors such as variation in seasonal illness severity and national changes in healthcare provision and structure, for example in primary care, may contribute to mortality and length of stay. It should be noted that the reductions in mortality rates in our trust were at a time when national mortality figures were increasing. We were unable to directly adjust our analyses for illness severity, as the acuity data were collected as a separate audit that was not directly linked to the main dataset. Similarly, we were unable to obtain data on readmission rates to ensure the reduced length of stay was not offset by a higher rate of readmissions within 30 days.

We consider it would be wise to exercise caution in the interpretation of data based on retrospective observation of mortality and length of stay. While our data suggest the introduction of enhanced seven-day working is associated with significant reductions in mortality, increases in discharges and reductions in length of stay within the Medical Division, other unknown factors may have contributed. This study has suggested that improvements in mortality and length of stay in the Medical Division may be linked to the introduction of enhanced seven-day working. However it is essential that this work is retested under prospective and controlled circumstances. If confirmed, developments in health service planning should consider the value of enhanced seven-day working as a possible means of reducing mortality and improving cost effectiveness of healthcare.

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KEY POINTS

1. Significant increases in medical and non-medical staff resources are required for seven-day working to be established.
2. Seven-day working enables patients to see the right specialist earlier in their admission.
3. Seven-day working is possibly associated with reductions in mortality and length of stay.
4. Further prospective studies are required to confirm these findings.

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