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Hospital mortality scores are unduly influenced by changes in service configuration

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Key Points

- Changes in the number of hospital admissions leads to unexpected changes in hospital mortality score
- Increasing admissions via an assessment unit reduce patient acuity and reduce the mortality score
- Random removal of case-mix due to IT failure also generate changes in the mortality score
- The variation in SHMI is far beyond anything arising from chance
- Two simple charts are used to identify service configuration and other external effects on the mortality score

Introduction

Any hospital doctor will inform you that length of stay is a far better indicator of patient acuity than diagnosis. So why do hospital doctors continue to be harassed over supposed changes in hospital mortality generated by models which largely rely on diagnosis?

Some time ago I provided statistical support to the Mortality Review Group (MRG) at a UK Teaching Hospital. The MRG were mystified by the seeming meaningless meanderings of the hospital mortality score over time, and red herrings generated by two different measures of standardized mortality. I was asked to investigate if the (seemingly gold standard) models were the real problem rather than supposed deficiencies in hospital care [1-11]. Over 90% of deaths occur within internal medicine, however, it is known that only around 8% of hospital deaths are 'possibly preventable' [12]. It is highly unlikely that the 8% of 'potentially preventable' deaths were able to account for the undulations in supposed standardized hospital mortality.

This study investigates unexplained changes in standardized hospital mortality which seemingly arise from changes in the number of admissions, and associated acuity, rather than changes in hospital care.

Methods

The Summary Hospital-level Mortality Indicator (SHMI) score for English hospitals for the 12-months ending Jun-13 through to Jun-17 were obtained from NHS Digital [13]. The SHMI score includes deaths within 30-days of discharge. The trends are analysed using charts with additional commentary. Hospitals were ranked based on the maximum change in admissions over the study period.

Results

In all the following figures the start of the time series (12-months ending June 2013) is marked by a square and the end (12-months ending June 2017) by a triangle. The calculated SHMI score is always over 12-months but moves forward by three months at each recalculation of the score. A SHMI score of 1.0 represents national average.

Figure 1. Trend in SHMI at North Middlesex hospital (outer London) following a large capacity shock

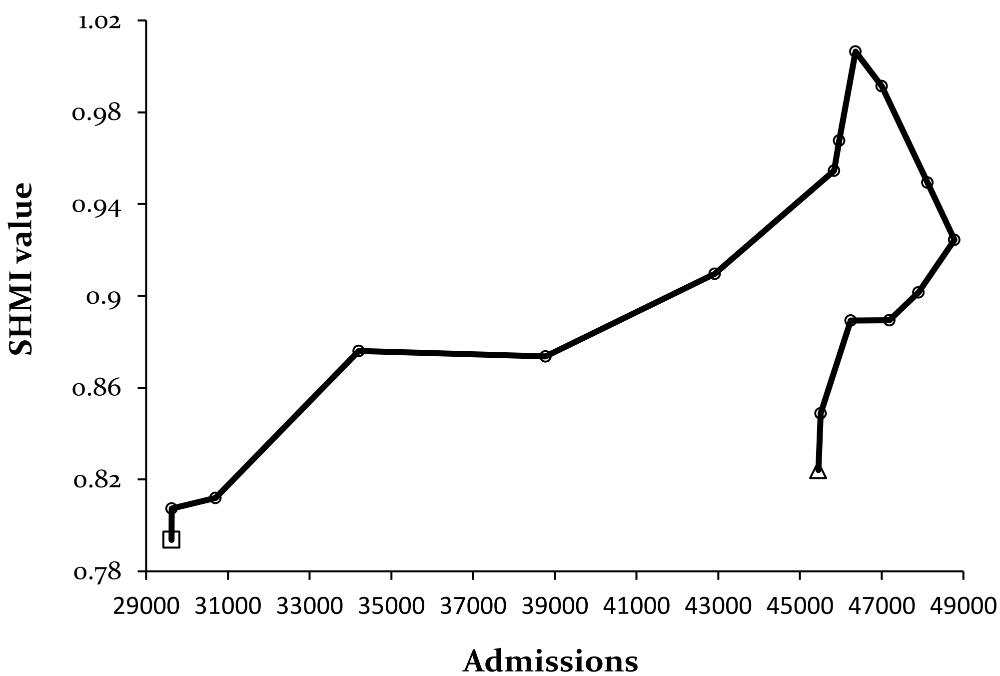


Figure 1 presents the results for North Middlesex hospital which experienced a huge capacity shock in January 2014 due to the closure of a nearby emergency department (ED). The closure of the nearby ED was instigated to save money and it is unsure who took ultimate responsibility for the accuracy of the capacity calculations and their implications to resources in the before/after scenario.

The hospital commences with an average of 30,000 admissions and an average SHMI score of 0.804 up to December 2013. In the 12-months after the capacity shock admissions have jumped to around 46,000. This shows as a trend upward in the chart since the first value after the capacity shock includes 9-months of the old level of admissions plus 3-months of the new level, etc. Admissions continue to increase to a maximum of 49,000 in the 12-months ending March 2016, followed by a drop to 45,500 after this point as admissions are moved to other hospitals.

Figure 2. Trend in SHMI at the Barking, Havering and Redbridge hospitals group.

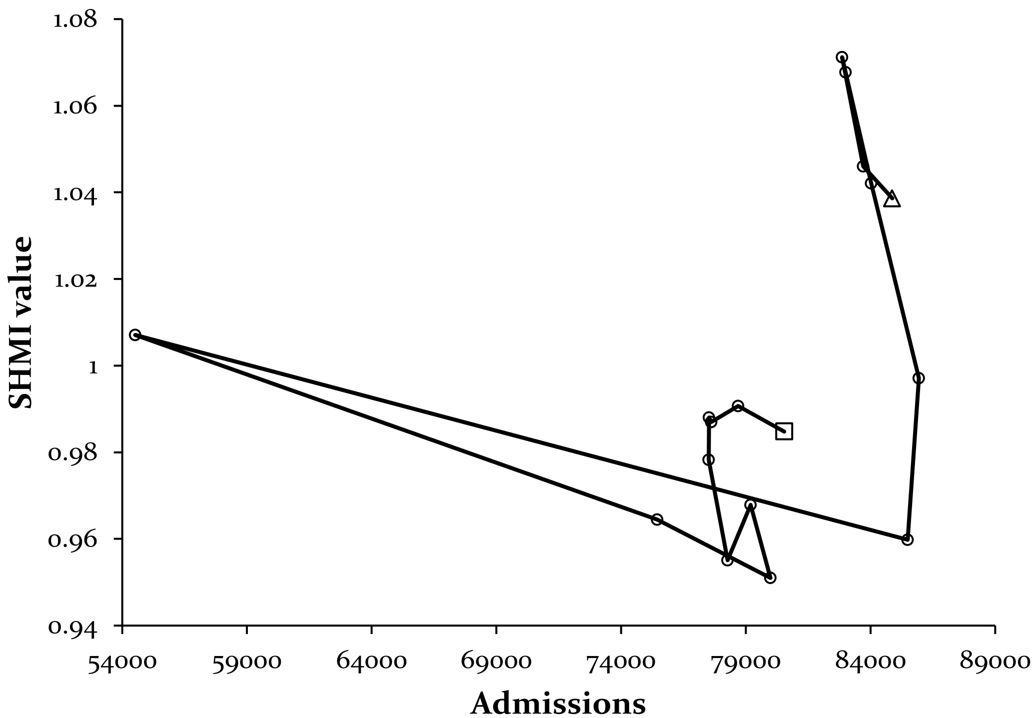
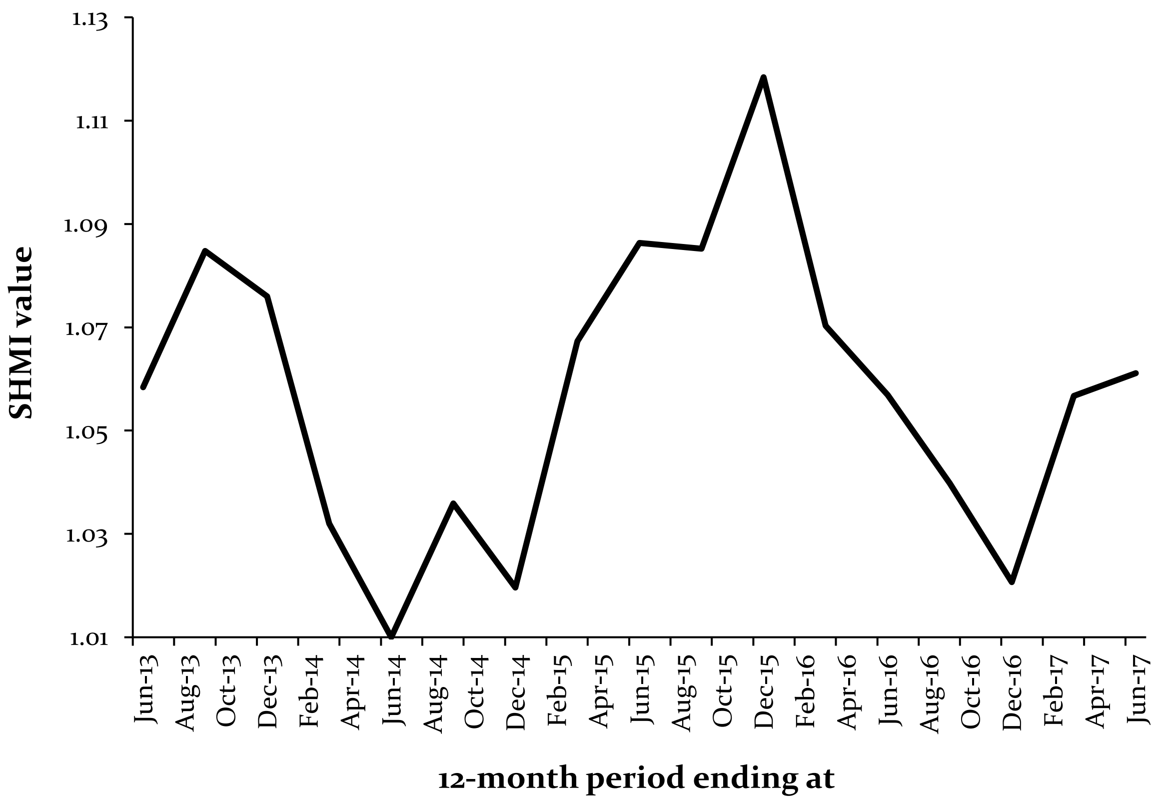


Figure 2 shows the trend in SHMI at the Barking, Havering and Redbridge hospitals group (Queens hospital in Romford and King George hospital in Ilford) in East London. The trend includes a change in SHMI due to 30% data loss in the period July to September 2015 during a service change which takes admissions from around 79,000 to 84,000. After the service change, additional changes in London and nearby Essex will subtly influence casemix and acuity.

Figure 3 shows the trend at Salisbury hospital which has the least change in admissions of any English hospital over the study period, with only a 1,450 difference between least (34,244 for the 12-months ending March 2014) and most admissions (35,697 for the 12-months ending September 2016). This trend is shown over time to illustrate common on/off or high/low switching behavior in SMHI which is common among hospitals where there are no major configuration changes.

Figure 3. Trend in SHMI at Salisbury hospital (Wiltshire)



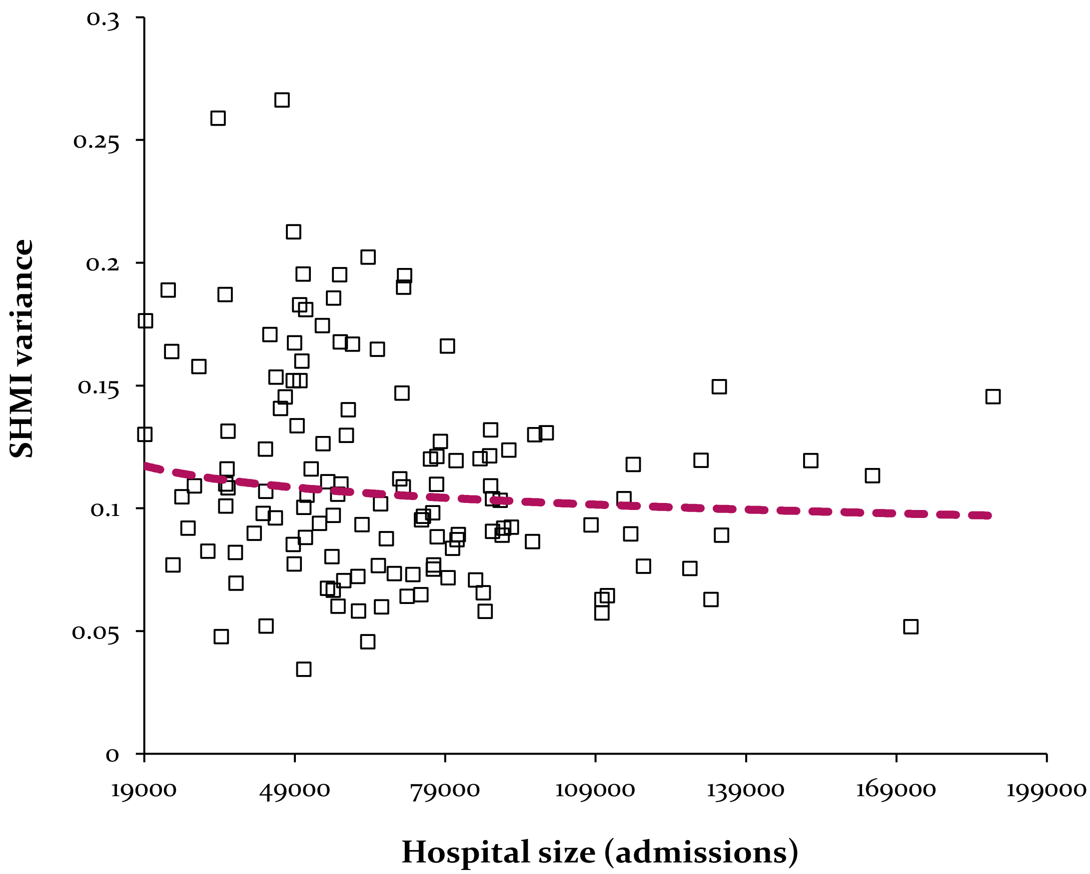
Further examples are given in the Supplementary material which includes changes in admissions due to data loss in IT glitches, i.e. random removal of casemix.

Finally, Figure 4 gives the variance in the SHMI value (maximum – minimum) plotted against the number of admissions at each hospital. Also given as the dashed line is the value of the over dispersion. Over dispersion reflects the combined effect of chance variation plus variation arising from the SHMI model. Some 47% of hospitals show higher variance in SHMI than the value of the overdispersion.

Discussion

The main point in Figs 1-3 is that the SHMI value moves in definite trajectories based on changes in the organization of healthcare services or the external environment, and that SHMI only shows minor variation when the system is at steady state. For example, before the capacity shock at the North Middlesex hospital the SHMI value only showed a standard deviation of ± 0.0095 (less than ± 1%). It is unknown if the peak in the SHMI value of 1.0064 for the 12-months ending Jun-15 represented higher deaths due to poor care or was simply a result of changing admissions and casemix.

Figure 4: Maximum variance in SHMI versus hospital size (admissions)



In theory, SHMI and other measures of standardized hospital mortality are casemix adjusted [1]. In practice, this adjustment is very crude and lacks the refinement which allowance for length of stay or acuity would afford [1,5,7]. Regulators argue against the inclusion of length of stay (LOS) because (they claim) it would disadvantage 'efficient' hospitals with a lower LOS. LOS does however greatly depend on the ability to discharge patients into the surrounding non-acute environment which includes hospices, nursing homes, step-down facilities in community hospitals, community nurses supporting in-home care, transfers to specialist hospitals and dedicated rehabilitation facilities. In this case LOS 'efficiency' is a debatable term [14,15], and most doctors would rightly point out that patients are generally not kept in hospital any longer than is necessary.

English hospitals have great freedom to reorganize their services and even how they count an 'admission'. For example, there is considerable ambiguity in the boundary between the ED and assessment/observation units, and as a result, English hospitals have around 1.8 million same day stay 'emergency admissions' [16]. These 'admissions' have mostly accumulated since 2002 when a 4-hour target was introduced for a patient stay in the ED [5] and may well be counted as an ED attendance in other countries. The number of admissions made via assessment/observation units is constantly changing as units are expanded or Purchasers challenge counting practices and demand that some of the more dubious changes in counting (and hence costs) are reversed.

Clearly the patients ‘admitted’ to an assessment unit have a very different casemix and acuity to those with a genuine need for overnight stay(s). It should come as no surprise that hospitals with more same day stay ‘emergency admissions’ generally have a lower SHMI score, i.e. SHMI is merely reflecting lower acuity [5].

In addition, the health behaviors and hence casemix associated with different social groups [17,18] imply that changes in service configuration and associated admissions, as in Fig’s 1 and 2 will lead to subtle changes in casemix and acuity which will not be reflected in a diagnosis. Current models for hospital mortality do not adjust for the effects of social group on acuity. Random removal of casemix due to IT failures (as in Figure 2 and in the Supplementary material) also generate large changes in SHMI which have nothing to do with hospital care.

It has recently been demonstrated that much of the so-called weekend mortality effect is an artefact of lower numbers of higher acuity patients admitted over the weekend [7,19], and that the apparent excess weekend mortality score varies considerably at the same hospital from year-to-year [10].

It is of interest to note that Fig. 3 gives a further example of curious on/off switching in hospital mortality which appears to occur in response to changes in total number of deaths (all-cause mortality) in the community surrounding each hospital [1,20-22]. In Figure 3 switch-on to a higher SHMI occurs shortly after the valleys, or four quarters back from a peak. Hence, in September 2012, December 2014 and December 2016. This effect will occur since almost half of a person’s lifetime admissions occur in the last year of life, irrespective of age at death [23-25]. Hence space-time (spatiotemporal) differences in deaths [1,26], and their associated real cause(s), are driving the appearance of changes in hospital mortality at different times in hospitals. These patterns lie hidden within the larger changes in hospital mortality induced by service reconfiguration illustrated in Figures 1 to 3.

Finally, Fig. 4 investigated if the variance in SHMI was related to hospital size or the value of over dispersion for each hospital calculated for the SHMI model. The SHMI value for each hospital is usually displayed on a fan-chart and values above the upper and lower limits for over dispersion are flagged as outliers. The maximum limit for over dispersion ranges from a SHMI value of 1.1267 for the smallest hospital through to 1.0991 for the largest hospital. Hence if we were to assume all hospitals were at national average for SHMI their SHMI score could theoretically increase/decrease by around ± 0.099 to 0.127 before they were declared a SHMI outlier. This suggests that the magnitude of the ‘real world’ variance observed in SHMI is arising from factors other than those anticipated by the SHMI model.

Conclusions

Current models for standardized hospital mortality are prone to reflect changes in casemix and acuity arising from service reconfiguration rather than genuine changes in hospital care standards. At the very least the models need to be modified to reflect length of stay as a proxy for acuity. Doctors can use the simple analysis presented in this paper (Figs 1 and 2 versus Fig 3) to urge hospital managers to ponder likely non-hospital causes for changes in the hospital mortality score, and this may avert needless calls for clinical audit. Modification of hospital mortality models to reflect subtle differences due to social group are also recommended.

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Supplementary Material

Figure S1: Trend in SHMI at the Royal Berkshire hospital in Reading. Changes in admissions due to counting and a decrease due to an IT failure

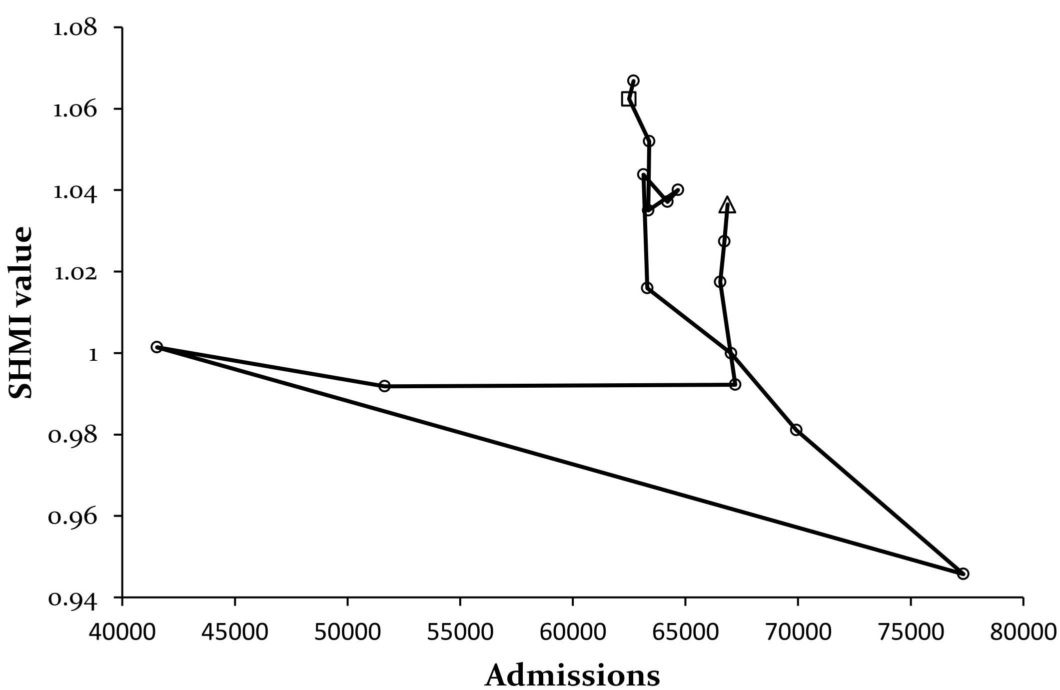


Figure S2: Trends in SHMI at the Northumbria group of hospitals during a period of service change and reconfiguration among group hospitals

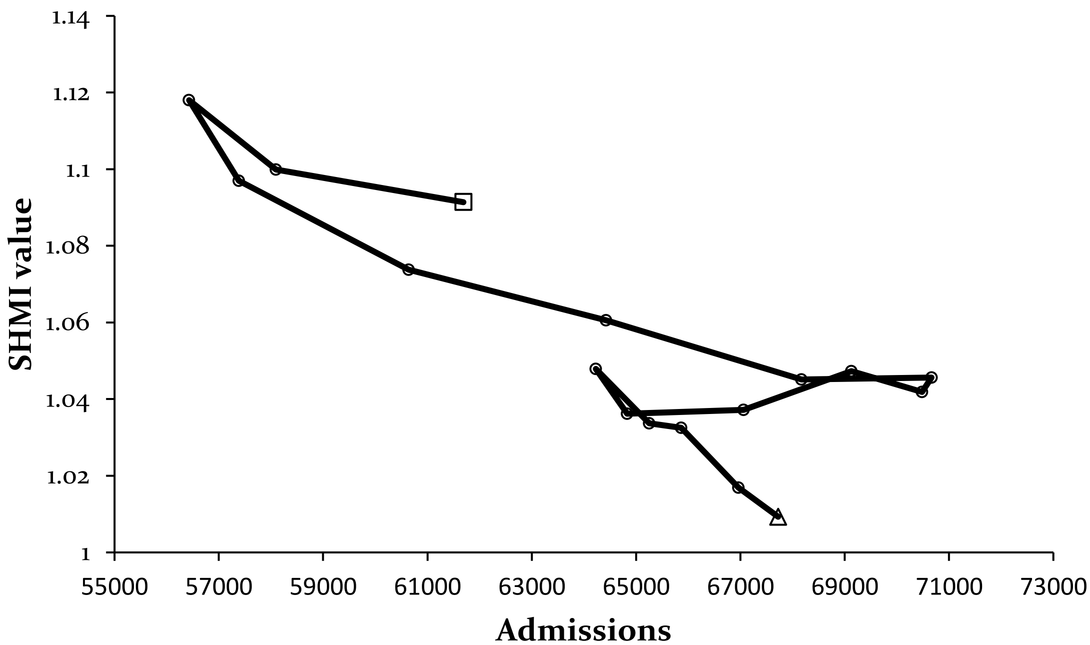


Figure S3: Trend in SHMI at the Heart of England hospital group (Birmingham) during an expansion in assessment unit capacity leading to a shift to lower overall acuity and SHMI

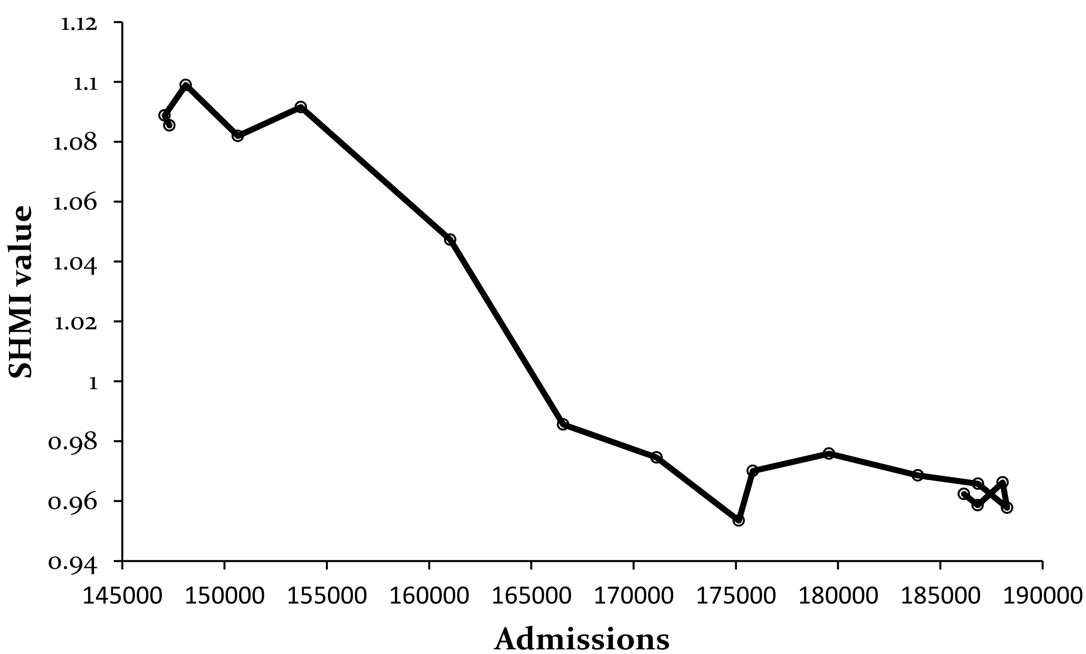
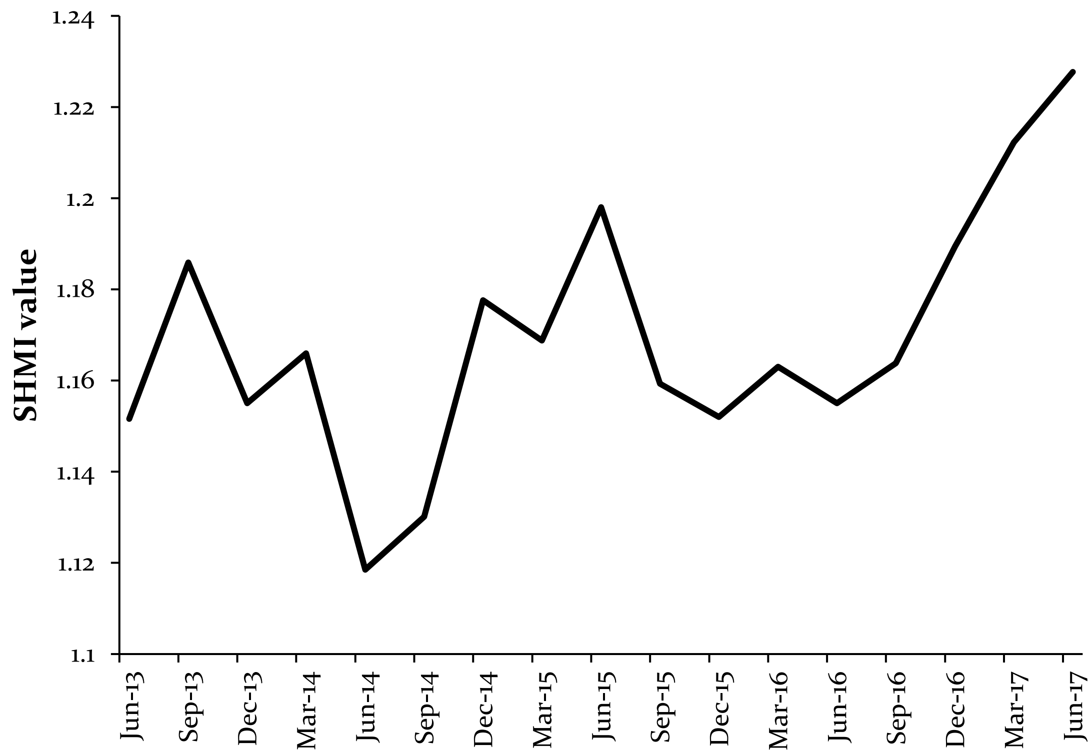


Figure S4: Trends in SHMI at Wye Valley hospital, a small acute hospital, with no major changes in admissions



Footnote: The switch-on for mortality occurs shortly after Jun-12, Jun-14 and Jun-16