The Safer Nursing Care Tool as a guide to nurse staffing requirements on hospital wards: observational and modelling study

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Scientific summary

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Scientific summary

Background

Several reviews of research show that higher registered nurse staffing levels in hospitals are associated with better patient outcomes and care quality. There are many systems available to assist with deciding the number of nursing staff needed on wards. However, evidence is lacking about the effectiveness or efficiency of staffing levels set using these approaches. Nonetheless, in 2014 the National Institute for Health and Care Excellence endorsed using the Safer Nursing Care Tool as a decision support tool for setting nurse staffing levels on adult inpatient wards. The Safer Nursing Care Tool works by categorising patients according to their acuity and dependency on nursing care. Each category is associated with a workload 'multiplier', used to determine the number of nursing staff to employ.

Objectives

- Explore variation in demand measured using the tool from day to day and between days in order to understand the accuracy of estimated establishments and how well establishments based on mean demand match variable patient need.
- Determine how current staffing matches the staffing requirements measured by the tool.
- Assess whether or not a mismatch between the staffing requirements measured by the tool and the number of staff deployed is associated with nurses' perceptions of staffing adequacy.
- Explore the influence of factors other than patient characteristics, such as the numbers of admissions and discharges to the ward.
- Develop mathematical simulation models to explore scenarios with flexible staffing policies and different approaches to using the tool to set staffing establishments.
- Model the costs and consequences of alternative staffing policies considering:
    - opportunities to deploy staff from 'overstaffed' wards to 'understaffed' wards
    - costs of temporary staff
    - relative efficiencies of different staff groups
    - adverse outcomes of understaffing.

Design, setting and methods

This is an observational study using administrative data, nurses' assessments of patients using the Safer Nursing Care Tool and reports of staffing adequacy from 81 acute medical/surgical wards in four NHS hospital trusts.

Main outcome measures

For each ward and shift, we measured the apparent 'shortfall', that is the deviation between the staffing requirement estimated using the Safer Nursing Care Tool and the actual staffing, as well as asking ward leaders whether or not there were enough staff for quality, whether or not any nursing care was left undone, whether or not staff missed breaks and how many staff (registered nurses and nursing support workers) they judged were needed.

Our simulation models estimated the percentage of patient shifts that were staffed more than 15% below the requirement and the staff cost per patient-day. From this, we estimated the costs per life saved associated with different staffing establishments.

Data sources

We used data from patient administration systems, staff rosters and Bedview® (CareView Communications Inc., Lewisville, TX, USA)/SafeCare® (Allocate Software, London, UK) (for nurse assessments of patients' Safer Nursing Care Tool acuity/dependency categories) and ward profiles. We used a variety of published sources to estimate standard costs and the impact of low staffing on outcomes for our economic modelling.

Patient data were de-identified by pseudonymisation at source. We cleaned data, removing extreme values of deployed staffing and estimated staffing requirements, and days with zero patients. We removed invalid data in the reports of staffing adequacy by following a series of logical rules.

Analysis

Using both bootstrapping and traditional power calculations, we estimated the sample size needed to obtain a stable estimate of the mean staffing requirement, which is used by the tool to determine the number of staff to employ. We assessed the variation in estimated staffing requirements between the morning and evening census points by calculating differences and intracluster correlation coefficients. We compared the average staffing requirements on different days of the week.

We fitted multilevel regression models nested at the ward and hospital levels to assess the association between 'shortfall' according to the tool and ward leaders' reports of staffing adequacy. We included other factors that may affect this relationship: patient turnover, ward type (medical, surgical or mixed), the proportion of single rooms, day of the week and time of day.

We developed a Monte Carlo, agent-based computer simulation model for investigating alternative approaches to using the tool for setting staffing levels, and different flexible staffing policies. The 'agents' are the wards, which interact by providing spare staff to (and receiving additional staff from) each other. For each shift, the model simulates the numbers of patients in each acuity/dependency category, the number of one-to-one 'specials', available staff, staff re-deployments between wards and extra staff hired from bank and agency. The settings and parameters are based on real data and assumptions agreed with local investigators at each hospital trust. For core models, we used empirical data obtained from one hospital trust to estimate the availability of temporary staff, but we also considered higher availability.

The simulation calculates staffing costs and assesses whether each ward is understaffed, adequately staffed or overstaffed. We compared the effects and costs of a 'high' establishment (set to meet demand on 90% of days), the 'standard' (mean-based) establishment and a 'flexible (low)' establishment (80% of the mean) providing a core staff group that would be sufficient on days of low demand, with flexible staff re-deployed/hired to meet fluctuations in demand.

We used coefficients from previous research linking nurse staffing shortfalls with mortality to estimate the cost-effectiveness of the different staffing scenarios.

Results

We received Safer Nursing Care Tool ratings for 96% of possible wards × days. In all, we obtained data linking Safer Nursing Care Tool ratings and staffing levels for 26,362 wards × days.

Average ward staffing requirements estimated by the Safer Nursing Care Tool varied from 5.9 to 10.2 hours per patient-day. The required staffing varied considerably between days on the same ward, with hospital trust mean within-ward standard deviations between 0.42 and 0.94 hours per patient-day. The required staffing estimated by the Safer Nursing Care Tool was slightly higher than the staffing we observed to be deployed in three general hospital trusts, and considerably lower than staffing deployed in the specialist hospital trust. Including specialing requirements substantially increased the variability of requirements between days.

The sample size needed for a stable estimate of the mean average staffing requirement depends on the margin of error that is acceptable and the variability of staffing requirements for a particular ward. Using the power calculation approach, we found that an average of 959, 240 and 60 observations would be needed for 95% confidence intervals of width 0.5, 1 and 2 whole-time equivalents, respectively, but there was much variation at ward level. The bootstrapping approach gave similar results. Overall, the time of day when the Safer Nursing Care Tool was assessed made very little difference to the calculated establishment (< 1% on average), but for some wards the admission/discharge patterns meant that there were large differences.

When the registered nurse staffing level was 1 hour per patient-day below the required level estimated using the Safer Nursing Care Tool, the odds of the shift leader reporting that there were enough staff for quality were reduced by 11%, the odds of reporting nursing care left undone were increased by 14% and the odds of reporting staff missing breaks were increased by 12% (all $p < 0.001$). The results for support worker shortfall were similar.

However, the regression models also highlighted that some factors not considered directly in the Safer Nursing Care Tool may also be related to professional judgements about the adequacy of staffing. Although the effects were not always significant, nurses in charge of wards with a higher proportion of single rooms were more likely to report care left undone. Nurses in charge of surgical wards were more likely than those on medical/mixed wards to report nursing care left undone and missed breaks, and less likely to report enough staff for quality. Patient turnover per day (measured as admissions, discharges and transfers per care hour) was not significant in the models, although large non-significant associations were consistent with turnover increasing nurse workload.

We found no clear pattern by day of week, but Saturdays compared favourably with Mondays for all reported measures, although Sundays were no more likely to be seen as adequately staffed at any given level than were Mondays. In our models matching shifts rather than days, we found that night shifts were more likely than morning or afternoon shifts to be perceived as adequately staffed for all three measures.

We found limited evidence of non-linear effects and interactions between staff groups, but these appeared to have little appreciable impact on estimated effects. In particular, there was no clear threshold consistent with the Safer Nursing Care Tool indicating an optimal staffing level because outcomes improved as staffing rose above the measured 'requirement', with no clear evidence of diminishing returns.

Our simulation model used data from our observational study to model the consequences and costs of setting the establishment using the Safer Nursing Care Tool: 'high' establishments (set to match the level of demand observed on 90% of occasions) and 'flexible (low)' establishments (set to meet 80% of observed average need) compared with the 'standard' approach where staffing is set to meet mean demand. Compared with the 'standard' (mean average) approach to setting the establishment, the 'high' establishments were 10% higher, on average, across the four hospital trusts.

Despite using temporary staff, on average across the hospitals the 'flexible (low)' establishment resulted in 63% of patient shifts falling ≤ 15% below the required staffing level. The standard establishment resulted in 31% of patient shifts with understaffing, whereas the 'high' staffing establishment resulted in 19% of patient shifts with understaffing. Overstaffing by > 15% above the requirement was less common, occurring on average on 15%, 7% and < 2% of patient shifts when using 'high', 'standard' and 'flexible (low)' establishments, respectively.

Increased staffing costs associated with the 'high' staffing establishments varied by hospital trust but were, on average, £11 per patient-day higher (8%). 'Flexible (low)' staffing establishments were associated with daily savings of £15 per patient-day (11%), mostly because of unfulfilled demand. The differences in both understaffed shifts and costs reduce if greater availability of temporary staff is assumed.

Even with high availability of temporary staffing, 'flexible (low)' establishments are associated with high rates of understaffing because a threshold based on 'whole people' has to be reached to trigger a request for additional staff, actual patient need varies and we assume temporary staffing to be less efficient. Assuming unlimited agency availability, 'flexible (low)' establishments are associated with understaffing on 21.4% of patient shifts and a cost saving of only £3 per patient-day (2%).

In our economic models, 'high' establishments are associated with a 1.2% reduction in bed-days used, and a relative reduction of 4.5% in the risk of death compared with 'standard' establishments. This equates to one life 'saved' for every 665 patients admitted to a hospital (number needed to treat). The additional staff costs per life saved are £20,423, with a net cost (after taking account of the value of bed-days saved) of £9506 per life saved. If the potential adverse effects of temporary staffing are included, the number needed to treat is smaller ($n = 627$), as is the cost per life saved (£19,390 staff costs and £8876 net).

'Flexible (low)' establishments are associated with an 8.3% increase in the risk of death, equating to one additional death for every 361 patients admitted (number needed to harm). The 'standard' (Safer Nursing Care Tool mean-based) establishment when compared with the 'flexible (low)' staffing gives a cost per life saved of £22,910 (net £13,967). As availability of temporary staffing increases, the cost per life saved of higher staffing establishments reduces.

Limitations

This is an observational study and cause and effect should not be assumed. Outcomes of staffing establishments are simulated. In the simulation modelling, we assumed that workloads in different wards were independent of one another. We did not track changes in acuity/dependency for individual patients, nor did we track possible changes linked to low staffing. We had to make many assumptions to develop a model, although, in general, the conclusions do not appear to be sensitive to these assumptions.

Conclusions

The hospital trusts in this study successfully implemented the Safer Nursing Care Tool and used it to guide establishment-setting. It is necessary to understand variation to decide the number of observations required to determine an establishment, but more than the recommended 20 observations may be required. Staffing levels measured by the tool are associated with professional judgement of staffing adequacy and so the tool has some degree of validity. To our knowledge, this is the first evidence that shows that the Safer Nursing Care Tool is related to professionals' assessments of what constitutes 'enough staff', although we cannot show that the tool provides a measure that is superior to professional judgement. The Safer Nursing Care Tool multipliers may not properly reflect the staffing requirements of

some units that are influenced by factors other than patient acuity/dependency. Smaller units and units with more single rooms may require more care hours per patient-day to provide adequate staffing to reliably meet patient need.

In modelling different approaches to using the tool to set ward establishments, we demonstrated that patient need can be met more reliably by setting the ward establishment at a level that is above the mean. Other approaches risk patients being exposed to very frequent low staffing, requiring the use of temporary staff, who are not always available. Because of the consequences of low staffing, higher establishments are potentially cost-effective when compared with lower ones. Our findings support flexible staffing policies guided by the Safer Nursing Care Tool, but such policies are cost-effective when based on establishments that are planned to meet patient need 90% of the time. A flexible staffing policy that sets establishments based on mean demand is also cost-effective when compared with a staffing policy based on a 'low' core establishment. This is in part because flexibility is constrained by limited availability of temporary staff and there are increased unit costs of staff. Flexible staffing with low base establishments is not effective. Furthermore, when temporary staffing availability is high, cost savings are largely eliminated. Although the routine deployment of systems that allow real-time calculation of staffing requirements can help with ongoing monitoring of a ward's staffing, for sufficient staffing to be delivered consistently, the priority remains correct determination of the necessary baseline. The best outcomes for patients are achieved at the highest establishments, but evidence from other studies shows that skill mix must be maintained.

Recommendations for research

Our recommendations for further research include:

1. more extensive observational studies, considering the potential influence of the availability of other professions and using other patient/staff outcomes to identify tipping points at which there are 'enough' staff and more staff would not improve outcomes further
2. prospective studies of the use of different approaches to determining staffing requirements, including assessing patient outcomes
3. investigating the fit of the Safer Nursing Care Tool at ward level
4. studying the variability of workload within acuity/dependency levels
5. simulation modelling of different priorities of nursing tasks and how much time is required as a buffer to have enough nurses when there are simultaneous urgent tasks
6. more detailed investigation into specialing requirements
7. development of simulation models of nurse staffing that model interdependence of staffing requirements in different wards
8. studying how much tolerance needs to be built in between the employment, deployment and rostering planning stages.

Trial registration

This trial is registered as ISRCTN12307968.

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