Nurse staffing levels, missed vital signs observations and mortality in hospital wards: modelling the consequences and costs of variations in nurse staffing and skill mix

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Prepared for the RCN International Research Conference, Oxford UK April 6-8 2017
This paper presents independent research funded by the National Institute for Health Research NIHR Health Services & Delivery Research programme (grant number 13/114/17).

The views expressed are those of the author and not necessarily those of the NHS, the NIHR or the Department of Health
Background

- Failure to ensure adequate nurse staffing levels implicated in NHS failures
  - Mid staffs
  - Keogh review
- NICE safe staffing guidelines identified limited direct evidence to guide staffing decisions
Many studies show an association between nurse staffing levels on hospital wards and patient safety outcomes: primarily mortality.

Causal relationship is unclear

- Most studies are cross sectional
- No direct measures of nursing care / causal path
- Cause can only be partial

Low Nurse staffing?  
Increased Mortality
Missed care: the missing link?

• “Missed care” is hypothesised as a mechanism by which short staffing affects outcomes

• Specifically missed or delayed opportunities to identify and intervene when patients deteriorate
  – Holds promise as a safe staffing indicator (NICE)

• Research exploring missed care largely limited to (nurse) self report

• Increasingly, electronic recording of nursing activities may allow us to fill the gap...
Aims

• ...to provide a basis for identifying the nurse staffing levels and skill mix required to ensure adequate patient surveillance
  – Examine the relationship between ward nurse staffing and adverse events assessed in terms of cardiac arrest calls, unanticipated ICU admissions and mortality.
  – Explore whether associations between nurse staffing and missed observations can provide a useful indicator of workforce adequacy to
Methods

• Single-site retrospective longitudinal observational study using routine data

• General medical surgical wards in a large (800 bed) general hospital (NHS Trust)

• Database linking patient details, vital signs observation and ward level nurse staffing at different levels.
  
  • Nursing Hours per patient day
  • Staffing below threshold for that ward
Data sources

• Electronic Rostering system, directly linked to payroll + Bank & agency shift
  – calculated HPPD

• PAS
  – Patient details, calculated patient level risk, mortality

• VitalPac
  – Derived measures of compliance with observations against a vital signs observations protocol based on an EWS
Setting and data

• 1 hospital

• 32 general medical / surgical wards including care of older people (exclusions maternity, ICU, paediatricics)

• 1,095 study days (1st April 2012 – 31st March 2015)

• 107,014 patients (at least 16 years old, who were admitted after study start date and discharged before study end date and spent some time on one of the study wards)

• 698,506 staff shifts
Key independent ‘control’

- Patient route of admission (early / elective)
- Patient SHMI risk (based on age, diagnosis, comorbidity – national model)
- Patient Acuity on Admission (validated Early Warning Score based on first vital signs)
- Ward (31 dummy variables 1/0 for each ward)
Key independent variables

- Patient exposed to Low staffing (RN & HCA Hours per patient day below the mean for the ward in) during first five days of stay (cumulative sum)
- Nurse staffing level relative to ward mean (+/- NHPPD)
- High patient turnover relative to staffing (admission per nurse >125% of mean for ward)
- Patient exposed to high bank and agency staff (1.5 hours or more per patient day)
Outcomes

- Patient: died vs discharged alive

- Ward (day) number of vital signs observations late vs ‘on time’ (i.e. within 2/3 of the time until next observation due
  
  – e.g. if the EWS scheduled an observation in 1 hour the observation was classified as missed once 1 hour 40 minutes had elapsed
Patient profile

- Age: (median/IQR): 61 (33.3) Gender M/F: 53%/47% Number of patients: 107 014
- Admissions: 82% emergency, 18% elective
- Overall mortality: 4% (Elective admissions < 1% Emergency 5%)
- Total length of stay (median/IQR): 2.1 (4.5)
- Charlson Co-morbidity index (median/IQR): 0 (8)
- Number of different SHMI groups represented: 138
- Number of different medical/surgical admission specialties: 60
Staffing levels

- 4.7 RN HPPD Unweighted average (ward level)
  - approx. 5.6 patients per nurse
    - Respiratory 8.2
    - Renal High care 2.5
- 1.4 HCA HPPD Unweighted average (ward level)
  - approx. 8.6 patients per HCA
    - CCU 17.2
    - Older people medicine 5.6
Missed Observations (by acuity / frequency category)
Survival analysis

Exposure to low staffing

Hazard of death
## Effects of staffing in the first 5 days

<table>
<thead>
<tr>
<th></th>
<th>HR</th>
<th>p</th>
<th>LCL</th>
<th>UCL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low RN staffing</strong></td>
<td>1.03</td>
<td>0.015</td>
<td>1.01</td>
<td>1.05</td>
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<tr>
<td>(below ward mean per day)</td>
<td></td>
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<tr>
<td><strong>Low HCA staffing</strong></td>
<td>1.04</td>
<td>0.001</td>
<td>1.02</td>
<td>1.07</td>
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<tr>
<td>(below ward mean per day)</td>
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<tr>
<td><strong>High admissions per RN</strong></td>
<td>1.05</td>
<td>0.019</td>
<td>1.01</td>
<td>1.10</td>
</tr>
<tr>
<td>(&gt;125% mean per day)</td>
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<td></td>
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</tr>
<tr>
<td><strong>High admissions per HCA</strong></td>
<td>1.00</td>
<td>0.820</td>
<td>0.95</td>
<td>1.04</td>
</tr>
<tr>
<td>(&gt;125% mean per day)</td>
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Controlling for ward, Acuity (first EWS), emergency admission & SHMI risk
**Temporary staffing**

<table>
<thead>
<tr>
<th>Days with more that 1.5 temp RN Hours per patient day</th>
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<th>UCL</th>
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<tr>
<td></td>
<td>1.12</td>
<td>0.006</td>
<td>1.03</td>
<td>1.21</td>
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</table>

<table>
<thead>
<tr>
<th>Days with more that 1.5 temp HCA Hours per patient day</th>
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<th>p</th>
<th>LCL</th>
<th>UCL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.04</td>
<td>0.023</td>
<td>1.01</td>
<td>1.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low RN staffing (below mean per day)</th>
<th>HR</th>
<th>p</th>
<th>LCL</th>
<th>UCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low HCA staffing (below mean per day)</td>
<td>1.03</td>
<td>0.023</td>
<td>1.00</td>
<td>1.05</td>
</tr>
<tr>
<td>High admissions per RN (&gt;125% mean per day)</td>
<td>1.05</td>
<td>0.038</td>
<td>1.00</td>
<td>1.09</td>
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<tr>
<td>High admissions per HCA (&gt;125% mean per day)</td>
<td>1.00</td>
<td>0.907</td>
<td>0.96</td>
<td>1.04</td>
</tr>
</tbody>
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Controlling for ward, Acuity (first EWS), emergency admission & SHMI risk.
Survival analysis

Variation in staffing levels

Rate of missed observations
Missed observations (in high acuity patients EWS≥6 – 4 hourly or more frequent observations)

<table>
<thead>
<tr>
<th>Variable</th>
<th>IRR</th>
<th>UCL</th>
<th>LCL</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>RN HPPD</td>
<td>0.98</td>
<td>0.998</td>
<td>0.965</td>
<td>0.026*</td>
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<tr>
<td>HCA HPPD</td>
<td>0.99</td>
<td>1.019</td>
<td>0.971</td>
<td>0.678</td>
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<td>Turnover (APN)</td>
<td>1.0</td>
<td>1.010</td>
<td>0.985</td>
<td>0.660</td>
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<tr>
<td>Nursing/HCA Interaction</td>
<td>1.0</td>
<td>1.004</td>
<td>0.996</td>
<td>0.943</td>
</tr>
</tbody>
</table>
• Current missed obs (median) 40%

• Adding an additional 2 RNHPP on average would be associated with a drop to 38.5%
Missed vital signs as a mediator?
Limitations

- Hours include supervisory time, breaks
- Non recording of staff redeployments
- Strengths
  - Few previous studies show prospective relationships and direct link between staffing and patients at individual level
Conclusions

• Low staffing associated with missed vital signs obs and increased mortality

• Associations significant but relatively weak

• Causal evidence
  – But role of missed obs still uncertain

• Risk associated with heavy use of bank and agency
  – But ? Off set

• Risk also independently associated with low HCA staffing

• Staffing changes need to be targeted
  – But these are not the only outcomes!
Implications

• Economic analysis & mediation to come but...
  – Most missed obs are NOT down to staffing levels
  – Unlikely to be able to use absolute levels of missed obs to guide staffing decisions
  – *Changes* can act as warning sign