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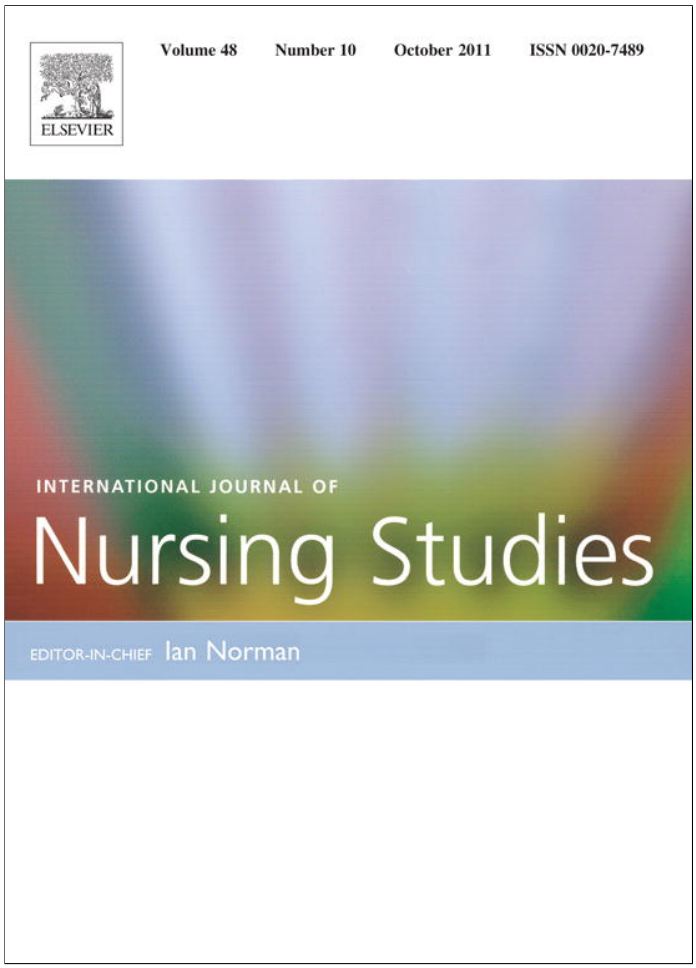

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Organisational quality, nurse staffing and the quality of chronic disease management in primary care: Observational study using routinely collected data

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ABSTRACT

Background: An association between quality of care and staffing levels, particularly registered nurses, has been established in acute hospitals. Recently an association between nurse staffing and quality of care for several chronic conditions has also been demonstrated for primary care in English general practice. A smaller body of literature identifies organisational factors, in particular issues of human resource management, as being a dominant factor. However the literature has tended to consider staffing and organisational factors separately.

Aims and objectives: We aim to determine whether relationships between the quality of clinical care and nurse staffing in general practice are attenuated or enhanced when organisational factors associated with quality of care are considered. We further aim to determine the relative contribution and interaction between these factors.

Method: We used routinely collected data from 8409 English general practices. The data, on organisational factors and the quality of clinical care for a range of long term conditions, is gathered as part of "Quality and Outcomes Framework" pay for performance system. Regression models exploring the relationship of staffing and organisational factors with care quality were fitted using MPLUS statistical modelling software.

Results: Higher levels of nurse staffing, clinical recording, education and reflection on the results of patient surveys were significantly associated with improved clinical care for COPD, CHD, Diabetes and Hypothyroidism after controlling for organisational factors. There was some evidence of attenuation of the estimated nurse staffing effect when organisational factors were considered, but this was small. The effect of staffing interacted significantly with the effect of organisational factors. Overall however, the characteristics that emerged as the strongest predictors of quality of clinical care were not staffing levels but the organisational factors of clinical recording, education and training and use of patient experience surveys.

Conclusions: Organisational factors contribute significantly to observed variation in the quality of care in English general practices. Levels of nurse staffing have an independent association with quality but also interact with organisational factors. The observed relationships are not necessarily causal but a causal relationship is plausible. The benefits and importance of education, training and personal development of nursing and other practice staff was clearly indicated.

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What is already known about the topic?

- Higher levels of nurse staffing have been associated with higher quality of care in hospitals and primary care.

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- Various organisational factors have also been associated with improved quality of care in hospitals.
- Few studies have examined staffing and organisational factors simultaneously to assess their relative contribution.

What this paper adds

- Both nurse staffing and organisational factors were associated with the quality of care for a range of chronic conditions in UK general practices.
- The association between quality and organisation was much stronger than the association with nurse staffing.
- There was an interaction between staffing and organisation which suggested that the adverse effects of the lowest levels of nurse staffing were mitigated by organisational quality.

There is a large literature exploring the association between quality, as measured by patient safety outcomes, and health care staffing levels, particularly registered nurses, in acute hospitals (Kane et al., 2007). A smaller but significant body of literature identifies organisational factors, in particular issues of human resource management, as being a dominant factor in care quality (Kazanjian et al., 2005). However this literature has tended to consider staffing and management factors separately. In addition to being limited to acute care settings this literature has rarely considered positive impacts on quality of care, focussing instead on safety. In this study we explore the associations between staffing levels, organisation and management factors and quality of care concurrently in a primary care setting.

In acute care, the term 'magnet hospital' has been used to describe hospitals where a number of organisational characteristics including leadership and management of the clinical (nursing) team, relationships with doctors (physicians) and support for education and training of nursing staff (Aiken et al., 1994) are associated with both better staffing and better patient outcomes. Because of this confounding it is unclear if there is an independent and causal effect of staffing despite the large number of studies suggesting that higher nurse staffing is associated with better outcomes (Kane et al., 2007). Some studies have directly assessed the effect of organisational characteristics. A systematic review identified the existence of associations between the work environment (autonomy, nursing workload, inter-professional relations, nursing management, nursing standards and professional development) and patient mortality in acute care (Kazanjian et al., 2005). However, most of this research did not consider staffing levels, which leaves open the possibility that positive organisational characteristics may be more important than staffing levels, or, conversely may simply be a product of well-resourced teams and increased capacity, and thus the precise organisational forms are not relevant to delivering good quality care.

One of the few studies to consider staffing and organisational factors concurrently undertaken by West and colleagues (West et al., 2002) did find strong associations between appraisal, training and team working and mortality after controlling for levels of medical staffing. However this research did not consider the level of nurse staffing which is the most researched staffing variable and one whose significance is well established (Kane et al., 2007). More recently (Aiken et al., 2008) found that the nursing work environment, which includes items exploring organisational factors such as staff development and quality management relationships, is more strongly associated with both nurse and patient outcomes in acute care settings than is nurse staffing.

The question of the relationship between quality of care and nurse staffing is particularly pertinent in primary care, since the contribution of nurses to clinical care in this area is hotly contested. In some countries the increased use of nurses in primary care has been driven by difficulty recruiting physicians or as a way of saving money (Pearce et al., 2010; Sox, 2000). In England increases in the use of nurses has been associated with the introduction of a 'pay for performance' system, the Quality and Outcomes Framework (QOF), for general practice. This system measures performance of the practice in clinical care for a number of disease areas (e.g. diabetes, coronary heart disease) and in terms of a number of organisational characteristics (e.g. length of appointments, personal learning plans for practice employed nurses) many of which are thought to support high quality care.

Much of the work involved in delivering the performance measured by the Quality and Outcomes Framework has been delegated by GPs to nurses (Leese, 2006) and over recent years there has been a steady increase in both the number of nurses employed in general practice and the proportion of consultations that are undertaken by them (Hippisley-Cox et al., 2007; The Information Centre, 2008). But concerns are consistently raised about the progression of the nursing role in primary care and the quality and safety of the care that nurses can give (Bagley et al., 2000; Burke, 2009; Knight, 2008). The contribution of nurses to meeting the Quality and Outcomes Framework targets in the UK has been dismissed as being essentially an exercise in form filling with no real contribution to the quality of care (Dr Crippen, 2010; Anon, 2007). If that was the case then once organisational factors were taken into account, for example systems for record keeping, then one would expect that the effect of nurse staffing would disappear or diminish.

Our previous paper showed a positive association between registered nurse staffing and the quality of care in English general practice (Griffiths et al., 2010a,b). A high level of nurse staffing (fewer patients per full time equivalent practice employed nurse) was significantly associated with better performance in a number of clinical conditions (e.g. chronic obstructive pulmonary disease (COPD) and Diabetes) suggesting that nurse staffing was associated with real differences in patient condition and not simply superficial compliance with processes. This reflects the research in hospital settings. However, in neither case is it clear whether the relationship observed is a causal one or whether the association with nurse staffing would remain once other factors are taken into account.

In this paper we determine whether relationships between the quality of clinical care and nurse staffing previously observed were attenuated when organisational

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factors pertinent to care in general were considered added to the model. We also explored the potential interaction between nurse staffing levels and organisational factors to determine if the effects of these factors varied depending on levels of staffing (or vice versa). In order to do this we used data on organisational factors from the Quality and Outcomes Framework to see what impact these had on the relationship between quality of care for the Quality and Outcomes Framework clinical conditions and nurse staffing.

1. Method

1.1. Data sources and sample

We used Quality and Outcomes Framework data for 2005/2006 obtained from the NHS Information Centre at Leeds (United Kingdom) as a source of data on both organisational factors and the quality of clinical care for a range of long term conditions: asthma, chronic obstructive pulmonary disease, coronary heart disease, diabetes, hypertension, hypothyroidism, severe long term mental health problems, and stroke. These data were matched to practice and population data. An estimate of the number of full-time equivalent (FTE) practice nurses employed by each practice was obtained using headcount data from Binleys, a health information specialist who have staffing information on every UK practice, and area data on full time equivalent numbers of nurses employed at the primary care trust level was obtained from the NHS Information Centre[1]. These sources of data are described in detail elsewhere (Griffiths et al., 2010a,b). The dataset contains information from 8409 practices. We excluded small practices (<1000 patients), practices without condition registers or no patients on the register, where registers were half the size of denominators used to calculate indicator specific achievement reporting and practices where an estimate of practice nurse staffing was not available. This reduced the number of practices to between 7431 and 7456 depending on the condition being studied.

The Quality and Outcomes Framework 2005/2006 comprises four domains (clinical, organisational, patient experience and additional services). We used the data on clinical care quality from the clinical domains as our dependant variables to measure the quality of clinical care and used organisational factors derived from the organisational and patient experiences domains as independent variables. We did not consider 'additional services' as these are generally services provided by the practice which do not impact upon the clinical conditions covered by the Quality and Outcomes Framework.

1.2. Variables

The Quality and Outcomes Framework clinical domain provides information on the quality of care for ten conditions. For each condition there is a set of indicators measuring process and intermediate outcomes: asthma (7), cancer (2), chronic obstructive pulmonary disease (8), coronary heart disease (CHD) (15), diabetes (18), epilepsy (4), hypertension (5), hypothyroidism (2), severe long term mental health (5), and stroke (10).

As this data is used as part of a pay for performance system and is not collected for research purposes there is a significant risk of bias. Achievement on the indicators can be expressed as reported achievement, used in the pay for performance system, where practices can exclude some patients from the denominator because they believe that the indicator does not apply. As this is open to manipulation by the practice we used the size of the condition register for the practice as the denominator and calculated population achievement instead, that is how many people in the entire population with the disease met the target specified in the indicator. Population achievement can only be calculated for those indicators that apply to all patients on the register. None of the indicators for cancer and epilepsy applied to all patients on this register so these two clinical conditions were omitted from the analysis. A composite score of weighted indicators was generated for each of these clinical conditions (Doran et al., 2006).

The patient experience domain comprises two elements related to how the practice manages patient experience. The first is the length of appointments offered (1 = routine booked appointments with doctors of not less than 10 minutes, 0 = length of consultation requirement not met). The second considers the practice's use of patient surveys. The three patient survey items were used to construct an ordinal variable that measures to what degree each practice utilised the survey (0 = not conducted, 1 = survey undertaken, 2 = survey undertaken, results reflected upon, changes proposed, 3 = survey undertaken, results discussed as a team, with a patient group/non-executive director of the primary care organisation, changes proposed and evidence these have been enacted upon).

The organisational domain consists of five areas. Each organisational area is represented by a set of indicators (Table 1): records and information about patients (19), patient communication (8), education and training (9), practice management (10), medicines management (10). Most of the time practices achieved the maximum score for each indicator because the standard was met (e.g. details of prescribed medicines are available to the prescriber at each surgery). For analysis purposes we collapsed the indicators into two categories (1 = met/maximum score 0 = not met/less than maximum score).

We undertook a factor analysis to identify underlying factors in the large number of individual organisational items. As the collapsed organisational indicator data are not continuous and do not conform to conventional (normal) distributional assumptions we used approaches based on tetrachoric correlations (a measure of correlation between two unobserved continuous variables), where each unobserved variable is represented by an observed dichotomous variable (Muthén, 1989). Tetrachoric correlations are calculated using a two stage procedure described in Brown and Benedetti (1977). Tetrachoric correlations are subject to increasing bias when expected cell frequencies in the bivariate table fall below 5 and so we

[1] Primary care trusts (PCTs) in England provide some health services and commission others for local areas comprising about 300,000 people. A PCT would typically include approximately 50 practices.

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Table 1
Confirmatory factor analysis–final model loadings and ancillary statistics.

Indicator	Factor			Residual variance	R^2	Indicator description
	1 (*G*)	2 (*R*)	3 (*E*)			
Records and information about patients						
REC1	1.00			0.19	0.81	Each patient contact **with a clinician** is recorded in the patient's record, including consultations, visits and telephone advice
REC2	0.83			0.45	0.56	Entries in the records are legible
REC3	1.08			0.06	0.95	The practice has a system for transferring and acting on information about patients seen by other doctors out of hours
REC5	1.07			0.08	0.93	The practice has a system for dealing with any hospital report or investigation result which identifies a responsible health professional, and ensures that any necessary action is taken
REC6	1.08			0.05	0.95	There is a system for ensuring that the relevant team members are informed about patients who have died
REC7	1.10			0.03	0.97	The medicines that a patient is receiving are clearly listed in his or her record
REC8	1.07			0.08	0.92	There is a designated place for the recording of drug allergies and adverse reactions in the notes and these are clearly recorded
REC9	0.54			0.77	0.24	For repeat medicines, an indication for the drug can be identified in the records (for drugs added to the repeat prescription with effect from 1 April 2004). Minimum Standard 80%
REC12	1.00			0.20	0.81	When a member of the team prescribes a medicine, there is a mechanism for that prescription to be entered into the patient's general practice record
REC13	0.91			0.34	0.67	There is a system to alert the out-of-hours service or duty doctor to patients dying at home
REC14	1.02			0.15	0.85	The records, hospital letters and investigation reports are filed in date order or available electronically in date order
REC15		1.00		0.51	0.49	The practice has up-to-date clinical summaries in at least 60% of patient records
REC16		1.13		0.36	0.64	The smoking status of patients aged from 15 to 75 is recorded for at least 75% of patients
REC17		0.91		0.59	0.41	The blood pressure of patients aged 45 and over is recorded in the preceding 5 years for at least 75% of patients
REC18						The practice has up-to-date clinical summaries in at least 80% of patient records
REC19		1.15		0.35	0.65	80% of newly registered patients have had their notes summarised within 8 weeks of receipt by the practice
Patient communication						
INF1	1.00			0.20	0.81	The practice has a system to allow patients to contact the out-of-hours service by making no more than two telephone calls
INF2	0.50			0.80	0.20	If an answering system is used out of hours, the message is clear and the contact number is given at least twice
INF3	1.05			0.11	0.90	The practice has arrangements for patients to speak to GPs and nurses on the telephone during the working day
INF4	0.95			0.28	0.72	If a patient is removed from a practice's list, the practice provides an explanation of the reasons in writing to the patient and information on how to find a new practice, unless it is perceived that such an action would result in a violent response by the patient
INF5	1.00			0.19	0.81	The practice supports smokers in stopping smoking by a strategy which includes providing literature and offering appropriate therapy
INF6	0.82			0.46	0.54	Information is available to patients on the roles of the GP, community midwife, health visitor and hospital clinics in the provision of ante-natal and post-natal care
INF7						Patients are able to access a receptionist via telephone and face to face in the practice, for at least 45 hours over 5 days, Monday to Friday, except where agreed with the PCO
INF8						The practice has a system to allow patients to contact the out-of-hours service by making no more than one telephone call
Practice management						
MAN1	0.98			0.23	0.77	Individual healthcare professionals have access to information on local procedures relating to Child Protection
MAN2	0.98			0.22	0.78	There are clearly defined arrangements for backing up computer data, back-up verification, safe storage of back-up tapes and authorisation for loading programmes where a computer is used
MAN3	0.69			0.62	0.38	The Hepatitis B status of all doctors and relevant practice-employed staff is recorded and immunisation recommended if required in accordance with national guidance
MAN4	0.72			0.59	0.41	The arrangements for instrument sterilisation comply with national guidelines as applicable to primary care
MAN5	0.91			0.33	0.68	The practice offers a range of appointment times to patients, which as a minimum should include morning and afternoon appointments five mornings and four afternoons per week, except where agreed with the PCO
MAN6	0.89			0.36	0.64	Person specifications and job descriptions are produced for all advertised vacancies
MAN7	0.79			0.50	0.50	The practice has systems in place to ensure regular and appropriate inspection, calibration, maintenance and replacement of equipment
MAN8						The practice has a policy to ensure the prevention of fraud and has defined levels of financial responsibility and accountability for staff undertaking financial transactions (accounts, payroll, drawings, payment of invoices, signing cheques, petty cash

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Table 1 (*Continued*)

Indicator	Factor			Residual variance	R^2	Indicator description
	1 (*G*)	2 (*R*)	3 (*E*)			
MAN9						The practice has a protocol for the identification of carers and a mechanism for the referral of carers for social services assessment
MAN10						There is a written procedures manual that includes staff employment policies including equal opportunities, bullying and harassment and sickness absence (including illegal drugs, alcohol and stress), to which staff have access
Medicines management						
MED1						Details of prescribed medicines are available to the prescriber at each surgery consultation
MED2	1.03			0.14	0.86	The practice possesses the equipment and in-date emergency drugs to treat anaphylaxis
MED3	1.02			0.16	0.84	There is a system for checking the expiry dates of emergency drugs on at least an annual basis
MED5						A medication review is recorded in the notes in the preceding 15 months for all patients being prescribed four or more repeat medicines Standard 80%
MED6	0.95			0.27	0.73	The practice meets the PCO prescribing adviser at least annually and agrees up to three actions related to prescribing
MED8	0.73			0.58	0.43	The number of hours from requesting a prescription to availability for collection by the patient is 48 hours or less (excluding weekends and bank/local holidays)
MED9						A medication review is recorded in the notes in the preceding 15 months for all patients being prescribed repeat medicines Standard 80%
MED10	0.68			0.63	0.38	The practice meets the PCO prescribing adviser at least annually, has agreed up to three actions related to prescribing and subsequently provided evidence of change
Education and training						
EDUC1			1.00	0.46	0.54	There is a record of all practice-employed clinical staff having attended Training/updating in basic life support skills in the preceding 18 months
EDUC2			1.34	0.02	0.98	The practice has undertaken a minimum of six significant event reviews in the past 3 years
EDUC3			1.16	0.27	0.73	All practice-employed nurses have an annual appraisal
EDUC4						All new staff receive induction training
EDUC5			0.97	0.49	0.51	There is a record of all practice-employed staff having attended training/updating in basic life support skills in the preceding 36 months
EDUC6			1.14	0.30	0.70	The practice conducts an annual review of patient complaints and suggestions to ascertain general learning points which are shared with the team
EDUC7			1.22	0.19	0.81	The practice has undertaken a minimum of twelve significant event reviews in the past 3 years
EDUC8			1.10	0.34	0.66	All practice-employed nurses have personal learning plans which have been reviewed at annual appraisal
EDUC9			1.10	0.34	0.66	All practice-employed non-clinical team members have an annual appraisal

removed variables which had several (five or more out of 55) correlations with low expected frequencies.

The remaining indicators were then factor analysed using MPLUS 4.2 statistical modelling software. All solutions from one to five factors were produced. As it seemed unlikely that the organisational factors we were exploring would be entirely independent of each other even when they addressed conceptually distinct issues because practices which succeed in one area of organisation are likely to do so in others, two or more factors were allowed to correlate. This was achieved by oblique rotation using the Promax method (Pett et al., 2003). Loadings of 0.4 and above were used to identify individual factors.

The fit of the model improved as the number of factors increased. All models except the single factor model had an RMSEA < 0.05 which indicates a good fit to the data. There was a sharp drop in the magnitude between the largest (29.288) and second largest eignenvalue (2.553). There is a second noticeable step change between the third (2.257) and fourth (1.427) largest eigenvalue suggesting that a three-factor solution was best. There was clear separation into three factors: a general organisation factor (*G*), a clinical recording factor (*R*) and an education and training factor (*E*).

In a few cases an indicator loaded highly on more than one factor. These indeterminate indicators were put aside along with indicators that did not load strongly on any factor. A confirmatory factor analysis (CFA) model was fitted to see whether the proposed model factor structure provided a good fit to the data and as a final diagnostic. This model fitted the data well on certain measures (TLI 0.969, RMSEA 0.029, and SRMR 0.029) but some of the residual variances were negative. Typically this involved two highly correlated indicators. Some further work, and exclusion of a small number of indicators, was required in order to ensure that there were no negative residual variances in the final model. The estimates for the final CFA model are shown in Table 1. Factor correlations were as follows: general organisation and clinical recording 0.57, general organisation and education and training factor 0.65 and clinical recording and education and training factor 0.61.

1.3. Statistical modelling

The independent variables were as follows:

- Practice organisational factors derived from the Quality and Outcomes Framework.

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- Geographic area and deprivation (density, Index of Multiple Deprivation).
- Patients characteristics (percent whose health was good, percent aged ≤15 years, percent who were female, percent aged ≥65 years, percent from a racial or ethnic minority).
- Practice characteristics (size, list size per full time equivalent (FTE) General Practitioner (medical doctor), single-handed practice, primary medical services contract).
- General practitioner characteristics (percent aged ≥45 years, percent female, percent qualified in the UK).
- Condition Prevalence
- Practice nurse staffing (practice list size per FTE practice nurses grouped into quintiles (≤3038.01, 3038.02–3901.48, 3901.49–4823.44, 4823.45–6210.68, and ≥6210.69)) with a sixth category for practices without a nurse.

The organisational factors identified by the factor analysis were treated as latent variables and all other variables as observed independent variables. A regression model was fitted simultaneously to all quality scores for all clinical conditions using MPLUS version 4.2. The unit of analysis was the practice. Although practices are clustered within primary care trusts and regions we did not use multi-level modelling as our previous work showed that variance associated with primary care trust was small compared to variance at the practice level (Griffiths et al., 2010a,b) and, furthermore, the multi-level model was not compatible with modelling multiple dependant variables simultaneously (the models did not converge). Typically variance associated with the trust was more than ten times smaller than that associated with practices.

We included geographic, patient, practice and practitioner characteristics in the model as several of these variables have been shown to have significant associations with quality of care in previous research. Thus while these variables were not of direct interest we needed to control for them while exploring those associations that directly interested us. Three other patient variables (per cent whose health was good, per cent aged ≤15 years, per cent who were female) were considered but excluded because of collinearity (Griffiths et al., 2010a,b).

Preliminary analysis also provided evidence of collinearity between the general organisation factor, clinical recording factor and education and training factors that we had derived from the organisational domain. When fitted individually, higher scores on each organisational factor were associated with higher Quality and Outcomes Framework composite scores. However when all three organisational factors were fitted simultaneously the sign of the β coefficient of the general factor went from positive to negative for most clinical conditions, indicating that there was collinearity. As statistical models typically assume that collinearity is not high we therefore dropped the general organisation factor from the model, as its specific meaning was less clear that the other two factors.

The effect of practice nurse staffing was tested by dropping this variable from the model and comparing the model fit (difference in fit between models). We determined whether the effect of practice nurse staffing was attenuated by the organisational factors by dropping them from the model and examining the differences between the β estimates for models.

To determine whether the effects of organisational factors were constant or varied with levels of nurse staffing we plotted clinical condition quality scores by practice nurse staffing and organisational factor score quintiles for the clinical recording and education and training factors and added an interaction term to the regression model. The global model (across all clinical conditions) with the interaction term failed to converge. We therefore fitted separate random effect models for each clinical condition using a Monte Carlo approach with between 1000 and 1500 integration points (Muthén and Muthén, 2007). Most of these models reached convergence. When convergence failed, the number of integration points was increased. The interaction could be tested for all clinical conditions and organisational factors except mental health (clinical recording), stroke (clinical recording) and COPD(education and training).

2. Results

The global effect of practice nurse staffing was statistically significant ($\chi^2 = 37.43$, 6d.f., $p < 0.001$). Practice nurse staffing was positively and significantly ($p < 0.01$) associated with quality of care scores for COPD, CHD, Diabetes, and Hypothyroidism (Table 2)[2]. The association between practice nurse staffing and hypertension was close to significance ($p = 0.053$). There were no significant association between quality of clinical care and list size per full-time equivalent GP ($p > 0.05$).

Clinical recording, education and training and making more use of the patient survey were significantly ($p < 0.001$) and positively related to clinical care quality as measured by Quality and Outcomes Framework composite scores for all clinical conditions. The effect of clinical recording was strongest for asthma, COPD and mental health and weakest for hypothyroidism, hypertension and CHD. The effect of education and training was strongest for asthma and mental health and weakest for CHD, hypertension and hypothyroidism. Those practices that had undertaken a patient survey each year, reflected on the results, proposed changes and discussed the results as a team with a patient group or non-executive director had significantly better care for all clinical conditions. The relationship between the length of consultation indicator and clinical quality scores was inconsistent and not always positive. For example, not meeting the required consultation length was associated with better scores for mental health ($p < 0.05$).

Amongst the other characteristics five or more significant associations were found for population density (5), percent of patients aged 65 and over (5), unadjusted

[2] Note degrees of freedom are calculated in a non-conventional way for difference testing when using the MPLUS WLSMV estimator in models containing both categorical and continuous dependent variables which was different to the more conventional approach using the Sartorra–Bentler method for models with continuous dependent variables only.

Table 2
Full regression model: association between organisational factors, nurse staffing and quality of care.

Characteristics	Asthma		COPD		CHD		Diabetes		Hypertension		Hypothyroidism		Mental health		Stroke	
	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)
Organisational factors																
Clinical recording	3.909[c]	0.408	3.159[c]	0.313	1.533[c]	0.125	2.632[c]	0.235	1.408[c]	0.109	0.727[c]	0.111	3.817[c]	0.601	1.951[c]	0.214
Education and training	1.154[c]	0.260	1.212[c]	0.197	0.385[c]	0.076	0.900[c]	0.144	0.389[c]	0.066	0.442[c]	0.071	1.448[c]	0.402	0.810[c]	0.149
Patient experience																
Length of consultations	−0.191	0.619	0.603	0.484	0.137	0.266	−0.080	0.437	0.480	0.265	0.405	0.262	−2.786[a]	1.137	0.731	0.401
Patient survey																
● Approved survey NOT undertaken	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
● Approved survey undertaken each year	−0.981	1.034	−0.553	0.840	0.476	0.413	0.822	0.645	1.214[a]	0.479	0.582	0.382	−2.945	1.852	−0.174	0.772
● and reflected on results and proposed changes	2.337[b]	0.797	1.510[a]	0.664	0.751[a]	0.326	1.976[c]	0.515	1.389[c]	0.339	1.193[c]	0.273	1.043	1.570	1.082	0.586
● and discussed results with as team with patient group/ Non-Exec director of PCO	7.328[c]	0.697	6.686[c]	0.591	2.692[c]	0.301	6.033[c]	0.473	3.416[c]	0.311	2.855[c]	0.236	5.641[c]	1.434	3.475[c]	0.536
Practice nurse staffing																
1st <3038.01	0.480	0.551	1.626	0.426	0.639[c]	0.187	1.227[c]	0.166	0.523[a]	0.206	0.924[c]	0.169	−0.160	0.858	0.222	0.275
2nd 3038.02–3901.48	0.097	0.560	1.459[c]	0.438	0.648[b]	0.200	1.603[c]	0.287	0.495[a]	0.216	0.764[c]	0.189	0.787	0.914	0.300	0.289
3rd 3901.49–4823.44	−0.357	0.570	1.031[a]	0.441	0.508[a]	0.206	1.352[c]	0.298	0.301	0.217	0.624[b]	0.192	0.001	0.921	0.132	0.301
4th 4823.45–6210.68	0.157	0.580	0.890	0.455	0.449[a]	0.195	1.093[c]	0.300	0.196	0.209	0.644[c]	0.187	0.304	0.922	0.069	0.294
5th 6210.69+	−0.167	0.584	0.590	0.455	0.413[a]	0.210	0.990[b]	0.302	0.084	0.221	0.499[a]	0.199	0.562	0.926	0.204	0.307
χ^2 difference test (p)	(p = .76)		(p< .001)		(p< .001)		(p< .001)		(p = .053)		(p< .001)		(p = .78)		(p = .62)	
Bias adjustment																
Denominator used to estimate register	4.334[c]	0.383	2.431[c]	0.236	0.998[c]	0.137	0.707[a]	0.310	0.274[a]	0.115	0.922[c]	0.114	12.178[c]	1.075	1.692[c]	0.188
Area																
Density (people per hectare 2001)	−0.268	0.143	−0.252[a]	0.108	−0.204[c]	0.054	−0.317[c]	0.082	−0.216[c]	0.057	−0.249[c]	0.052	−0.420	0.242	−0.137	0.077
Index of Multiple Deprivation	−0.170	0.159	−0.591[c]	0.121	0.010	0.064	−0.056	0.100	0.158[a]	0.072	0.111	0.065	−0.683[b]	0.262	−0.146	0.094
Patients																
≥65 yr of age	−0.601[b]	0.212	−0.141	0.156	−0.167[a]	0.082	−0.372[b]	0.123	0.122	0.084	−0.091	0.082	−1.765[c]	0.344	−0.424[c]	0.115
% member of racial or ethnic minority	−0.301	0.171	−0.025	0.133	−0.024	0.068	0.068	0.105	−0.005	0.076	−0.041	0.068	−0.189	0.308	−0.009	0.102
Prevalence																
Unadjusted prevalence	−0.122	0.144	−0.392[b]	0.130	−0.825[c]	0.086	−0.571[c]	0.081	−0.231[c]	0.049	0.334[c]	0.071	3.439	0.103	0.457[c]	0.120
Practice																
Size of practice population	−0.839[c]	0.188	−0.047	0.152	−0.112	0.075	0.023	0.114	−0.210[b]	0.080	−0.084	0.082	−0.448	0.281	−0.154	0.111
List size per FTE GP	−0.167	0.178	−0.050	0.157	−0.059	0.065	−0.119	0.115	−0.003	0.067	0.021	0.077	0.109	0.256	−0.023	0.108
Single handed practice	0.373	0.397	−0.693[a]	0.306	0.113	0.148	−0.262	0.238	−0.207	0.159	−0.236	0.153	−0.408	0.628	0.226	0.221
Primary medical services contract	−0.475	0.261	−0.067	0.201	−0.207[a]	0.101	−0.301[a]	0.153	−0.192	0.110	0.030	0.107	−1.062[a]	0.413	−0.253	0.153
Family practitioners																
≥45 yr of age	−0.020	0.144	−0.046	0.115	−0.084	0.056	−0.001	0.085	−0.070	0.062	−0.097	0.065	0.018	0.220	−0.039	0.083
% Female GPs	−0.071	0.125	0.078	0.096	−0.054	0.046	0.120	0.073	0.079	0.050	0.188[c]	0.048	0.203	0.207	0.172[a]	0.071
% GPs qualified in UK	−0.092	0.134	0.818[c]	0.108	0.402[c]	0.053	0.694[c]	0.080	0.251[c]	0.059	0.341[c]	0.055	−0.219	0.238	0.791[c]	0.081

β coefficients indicate the direction and relative strength of the association between independent and dependant variables in the model.
a < .05; b < .01; c < .001

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Table 3
Parameter estimates for practice nurse staffing in the model without organisational factors.

Practice nursing staffing	Asthma		COPD		CHD		Diabetes		Hypertension		Hypothyroidism		Mental health		Stroke	
	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)	β	se(β)
1st <3038.01	0.626	1.078	1.956[a]	0.880	0.798[a]	0.373	1.965[b]	0.611	0.709[a]	0.307	0.996[b]	0.328	−0.041	1.103	0.516	0.468
2nd 3038.02–3901.48	0.138	1.090	1.739	0.892	0.772[a]	0.379	1.656[b]	0.619	0.644[a]	0.314	0.834[a]	0.333	0.820	1.097	0.552	0.471
3rd 3901.49–4823.44	−0.383	1.105	1.199	0.916	0.595	0.403	1.338[a]	0.643	0.411	0.346	0.671	0.363	−0.024	1.125	0.306	0.493
4th 4823.45–6210.68	0.137	1.096	1.015	0.902	0.509	0.391	1.180	0.627	0.277	0.330	0.684[a]	0.339	0.320	1.108	0.182	0.479
5th 6210.69+	−0.367	1.099	0.578	0.908	0.437	0.385	0.826	0.628	0.128	0.329	0.517	0.339	0.541	1.116	0.282	0.477
No practice nurse	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
χ^2 difference test (p)	($p = .10$)		($p < .001$)		($p = .001$)		($p < .001$)		($p < .001$)		($p < .001$)		($p = .73$)		($p = .13$)	

a < .05; b < .01; c < .001

prevalence (7) and percent GPs qualified in the UK (6) (see Table 2 for full results).

Comparison of parameter estimates for practice nurse staffing in the model without organisational factors compared to the full models suggests that attenuation of the effect of staffing was minor. Parameter estimates, generally followed the same pattern in both models and were similar in magnitude. Parameter estimates for the effect of staffing that were significant in the full model (staffing and organisational factors) were on average 14.1% lower than in the model including only staffing (Table 3).

Where models converged, the test of interaction between practice nurse staffing and organisational factors was nearly always statistically significant ($p < 0.001$ in all cases except $p = 0.007$ for hypothyroidism (education and training), $p = 0.16$ for stroke (education and training factor)). A plot of clinical care quality scores by practice nurse staffing and organisational factor score quintiles for diabetes is shown in Fig. 1 for both the clinical recording and education and training factors. Plots for all other clinical conditions are found in Appendix 1. A common pattern emerged across many of the clinical conditions. Profiles by level of practice nurse staffing were generally similar for those practices that employed a practice nurse. The main difference to emerge was between practices with and without a practice nurse. The effect of not having a practice nurse appears to be mitigated by the organisational factors, so that the deficit is not apparent amongst practices without a practice nurse that score highly on organisational factors. This comes pattern is most clearly observed for diabetes (both factors), hypothyroidism (both factors), COPD (education and training) and stroke (education and training).

3. Discussion

Higher levels of nurse staffing, clinical recording, education and reflection on the results of patient surveys were all associated with improved clinical care across a range of conditions. The trend in increasing quality of clinical care with increased nurse staffing that we found previously (Griffiths et al., 2010a,b) was confirmed across several of the clinical conditions (COPD, CHD, Diabetes, and Hypothyroidism) after controlling for organisational factors. In almost all cases practices with practice nurses performed better than those without, even where the relationship was not significant. There was some evidence of attenuation of the estimated nurse staffing effect when organisational factors were considered but this was small, and so it appears that the observed association between staffing and quality is not simply a product of a global 'halo' of quality in better staffed and better run practices. The greatest differences in quality associated with nurse staffing were between practices that did and did not employ practice nurses. However, the findings suggest that the effect of not employing a practice nurse maybe compensated by the effect of higher levels of clinical recording and education and training.

Overall however, the characteristics that emerged as the strongest predictors of quality of clinical care were not staffing levels, but the organisational factors of clinical

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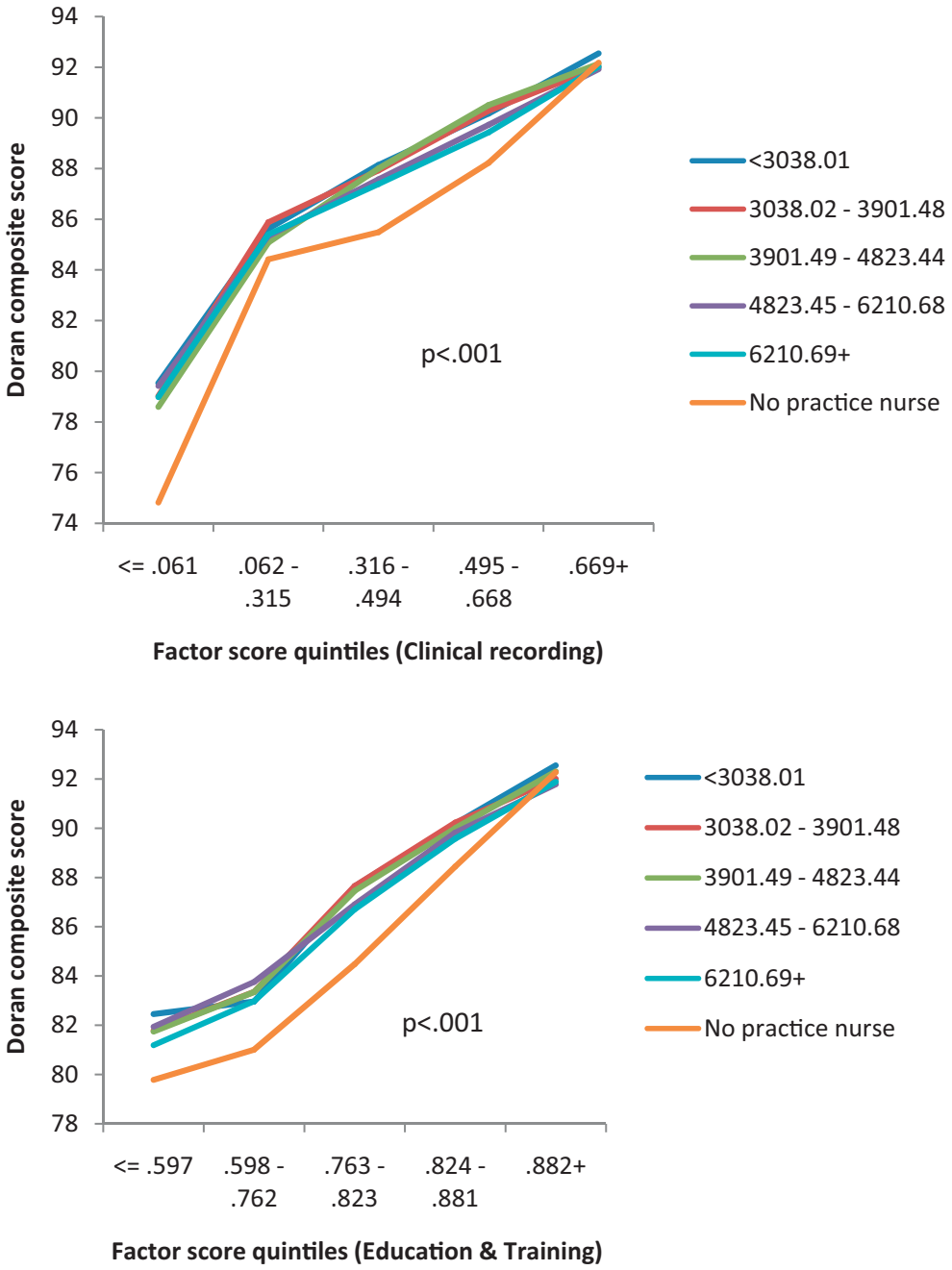

Fig. 1. Quality score for diabetes clinical care by clinical recording and education and training factor score quintiles.

recording, education and training and patient experience. The strength of these relationships between organisational factors and quality of care was of a higher order of magnitude than observed for nurse staffing.

This was a cross-sectional study and therefore we were not in a position to determine causality. While accepting this limitation, a causal relationship between clinical quality and both education and training and clinical recording is highly plausible. Human resource practices such as appraisal, personal development plans, review of significant events and patient complaints, etc. could, either directly or indirectly also lead to improvements in clinical performance as a result of more informed decisions based on higher quality clinical information and improved monitoring of patients. Similarly it is plausible that increased capacity associated with higher levels of nurse staffing has a causal effect on the quality of care. But while associations with levels of nurse staffing and clinical performance were evident, this was not the case for levels of GP staffing. However the additional clinical workload resulting from introduction of the general medical services contract in 2004 fell more on the shoulders of nurses, allowing doctors to devote greater time to chronic and preventative care (Gemmell et al., 2008). Therefore increased nurse staffing may be acting as proxy for the reconfiguration of service delivery and capacity for GPs to deliver this care.

3.1. Comparison with the existing literature

In common with research in acute care (Kane et al., 2007) this research shows an association between higher

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levels of nurse staffing and quality of care. Unlike most of the research from these settings this study has also shown that the association remains even, when controlling for the numbers of doctors and organisational factors, both of which have been shown to be associated with quality in acute care (Jarman et al., 1999; West et al., 2006). Systematic reviews (Gemmell et al., 2008) have shown that nurses can provide high quality care to patients with long-term conditions which is supported by this study.

However, the measures of quality used in the Quality and Outcomes Framework are primarily based on processes of care and intermediate outcomes, such as control of blood pressure. When examining hospital admissions the relationship between nurse staffing in primary care and quality is less clear. While higher nurse staffing in general practice is associated with fewer admissions for Asthma and COPD, it is associated with more admissions for diabetes (Griffiths et al., 2010a,b). Although the complexity of diabetes care raises doubts about the use of diabetes admissions as an indicator of quality in primary care, results such as this should serve as a reminder that causal inference remains problematic.

Organisational factors have been identified as significant predictors of quality in acute care. In hospital settings the extent of team working and training strategies have been linked to positive performance (West et al., 2002). Perceived quality of nurses' working environment, which included aspects of staff development as well as leadership and teamwork between nurses and doctors, has also been shown to be associated with mortality in acute care (Aiken et al., 2008). There is clearly more potential for team working in practices which employ nurses and it may be that the benefits associated with higher nurse staffing levels which we observed, which are mostly derived from employing *any* nurses, result from the increased potential for teamwork. Our study found that there were a small number of practices that did not employ a nurse who performed well when this was accompanied by high levels of clinical recording, suggesting that other organisational factors can compensate for this deficit. However, our dataset contained no direct measure of team working and so we were unable to explicitly explore this factor.

The evidence on staffing and outcome relationships in acute care has been used to advocate for mandatory staffing levels (Buchan, 2005). The argument for this is primarily based on concerns about patient safety in acute care settings and there are concerns that any minimum ratio could come to be regarded as a 'target' which did not adequately meet the needs of some patient groups (Spetz et al., 2009). It has also been suggested that legislating ratios for nurse staffing can be stifling for management and limit innovation (Buchan, 2005; Spetz et al., 2009). A more systematic approach to HR practices that goes beyond simply changing the skill mix through numbers of staff is required (Dubois and Singh, 2009).

While it is unlikely that similar proposals on staffing will emerge in primary care, it has been argued that practice nurses can provide care equal to or better than doctors (Burke, 2009) resulting in calls for further expansion of the nursing role. Efficiency gains are predicted if doctors withdraw from tasks that nurses can perform, to focus on the tasks only doctors can perform (Sibbald, 2008), which potentially leads to an increased demand for nurses. Concerns however remain about the level of training that practice nurses receive which, unlike doctors, is not regulated and therefore key competencies are not guaranteed. This study underlines the crucial importance of education and training of practice staff in ensuring that quality of care is maintained and enhanced. Getting practices to aspire to a rich mix of skilled staff working as a team is potentially less contentious than identifying a requirement for more of a specific staff group. In a similar vein, Dubois and Singh (2009) have suggested moving the human resource management focus away from skill-mix to skill management. The focus then becomes less about numbers of staff and more about the individual's abilities to adapt and adjust to the changing circumstances. This leads into discussions about aspects of healthcare staff roles (enhancement, enlargement, delegation, substitution) set in the context of patient need and organisational and institutional factors.

3.2. Strengths and limitations of the study

This study used data collected on all English GP practices. About 11% of practices had to be excluded on grounds of data quality and lack of available data to calculate nurse staffing estimates. Full time equivalent nurse staffing had to be estimated from headcount (number of employees) because data on full time equivalence is not routinely collected in the UK at the practice level, although this estimate appears robust (Griffiths et al., 2010a,b).

The organisational factors that we studied were determined by the available data. Performance on Quality and Outcomes Framework organisational indicators (and clinical domain indicators) was, and still is, used to determine payment to GP practices. How well they represent all the potential organisational factors that might impact on quality of care and whether they remain "fit for purpose" is open to question. Many of those used in 2005/2006 are still in use today, which suggests a degree of robustness, and they were selected for a specific purpose in mind; to improve clinical outcomes. However important factors, such as team work, could not be studied. Our model also lacked measures of staff wellbeing and perceptions of the organisational climate which, have also been identified as significant in other settings. These disadvantages should be set against the benefit of a population sample with very low unit (practice) and item (indicator) non response.

Certain assumptions underpin the factor analysis of dichotomous items that we performed. The approach proposed by (Muthén, 1989) appears to be robust to potential violations. The analysis was made more robust by removing a small number of indicators that produced low frequency counts when cross-tabulated with other indicators. The final factor structure is unlikely to have been affected greatly by their exclusion. We were unable to compute multi-level models to account for clustering of practices in primary care trusts. Other studies suggest that failure to account for clustering when the variance

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associated with the cluster is low makes no substantive change to conclusions, although estimation can be improved (Park and Lake, 2005). Furthermore the Primary Care Trust is primarily a geographical cluster and geographical factors (such as deprivation and urbanicity) were included in the model.

3.3. Implications for clinical practice and future research

The economic rationale for using more nurses is that they are cheaper to employ. This study shows that they can also be associated with improved quality of care but they should be deployed in areas where there is consistent evidence of equivalent or superior care to doctors (Sibbald et al., 2006). Salary savings could quite easily be lost by lower productivity (Goryakin et al., in press). Therefore role changes should be carefully targeted towards those areas where benefit has clearly been demonstrated previously or where there is a high level of confidence that benefits will result. This reallocation of activity from doctors to nurses can result in other benefits, for example allowing doctors to focus on more complex care. Therefore increased nurse staffing can result in both direct and indirect effects.

Although we should be wary of assuming that the cross sectional relationships we observed are causal, causality is highly plausible. These results highlight how important is the organisation and management of care, including human resource management, in delivering high quality clinical care in general practice. While nurse staffing levels were significant predictors of quality in several conditions the main effect was associated with having any practice nurses, which suggests that the benefit might derive from multi-disciplinary teams. The benefits of education, training and personal development of nurses in general practice were clearly indicated. In this research, the measurement of these organisational variables is coarse and there is ample scope for considerable variation in the quantity and quality of training and support provided to be masked. Further work should consider exploring the advantages of specific training for managing specific conditions (e.g. specialist courses in diabetes). General practice should recognise the potential advantages that derive from organisational development and investment in support for existing staff compared to the relatively modest benefits that derive from investing in more staff in isolation.

Conflict of interest

None declared.

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Ethical approval

Not required.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ijnurstu.2011.03.011.

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