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Examining the Cost-benefit of Additional Staffing in Long Term Care (LTC) Facilities

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Main Research Findings:

Variation of staff ratio and injury rates across care-levels:

- 'Total staff' ratios (residents/worker) decreased significantly across care levels. Median dayshift 'total staff' ratios (residents/worker) decreased steadily with increased funding across care-levels.
- "Total staff' injury rates varied significantly across care-levels.
- Staffing levels with increased funding across care-levels but did not compensate for the increased care intensity in each care-level. Multi-level Care (MC) facilities have the second highest funding compared to Extended Care (EC) facilities but nevertheless consistently have nearly twice the injury rates compared to EC facilities.

Variation of staff ratio and injury rates across occupations within each care-level.

- Injury rates and staff ratios varied significantly across occupational groups.
- Injury rates and staff ratios varied significantly within occupational groups.
- Each occupational group had its own unique staffing/injury-rate relationship. The total staff ratio and total injury rate at the facility level was not representative of the staffing/injury-rate relationship in the occupational groups.
- Registered nurses (RNs) had the lowest mean injury rate (7.68 injuries per 100 person-years) and the highest mean dayshift staff ratio (24.79) of all the occupational groups.
- Care Aides represent the highest mean injury rate (21.00 injuries per 100 person-years) the lowest mean dayshift staff ratio (8.38) of any individual occupation.

Confounding factors in the staffing/injury-rate relationship

- Care responsibilities have different meaning and different correlations to injury rates depending on the occupational job requirements. An increase in care responsibilities was associated with decreased injury-rates for RNs and LPNs but increased injury-rates for all other occupational groups.
- As the residents/RN ratio increases there is more likelihood that the RNs' tasks will be predominantly medical interventions and supervision with less likelihood for musculoskeletal injuries (MSI) due to patient lifting/transfers.
- As the resident/LPN ratio increases, there is increased probability that more time will be spent in the distribution of medication and less time for patient lifting/transferring tasks.
- For all other occupational groups an increase in resident/worker ratio increases physical workload and thereby increases risk of injury.
- The intensity of care needs for residents across care-levels can confound the staffing/injury-rate relationship by increasing workload per worker. The staffing/injury-rate relationship has to be analysed within each care-level.
- Although the WCB database provided the most accurate data available, analysis was compromised because there were too many unspecified claims with respect to: identifying occupational groups or the location code of the facility in which the injury occurred; and lack of time of injury resulted in an inability to linking injury to workload on specific shifts.

Correlation of staff ratio with injury rate:

- Very few correlations between injury rate and staff ratio were statistically significant within occupational groups.
- There were some statistically significant correlations of injury rate in one occupational group with staff ratio in another occupational group.
- Because of the care responsibility of RNs and LPNs (referred to above), their staff ratios correlate negatively with injury rates.

Logistic binary regression:

- Analysing for 'IC only', binary logistic regression showed a **linear trend** in the probability that the staffing/injury rate relationship would place injury rates in the lowest injury-rate quartile. This indicates that the relationship is quite straightforward with increases in staff ratio having a direct effect on injury rate.
- Analysing for 'IC only', binary logistic regression revealed **no linear trend** in the probability that any occupational staffing/injury-rate relationship would place injury rates within the highest injury-rate quartile. This finding of **non-linear trends** indicates that the staffing/injury-rate relationship is less direct with a change in staff ratio not leading to a direct change in injury rate. These different results in the lowest and highest injury-rate categories suggest there is a threshold somewhere between them where the staffing/injury-rate relationship shifts from direct to indirect relationship of the independent variable (staff ratio) and the dependent variable (injury rate). With regard to the staffing/injury-rate relationship, the non-linear trend in probability of being in a specific injury-rate category indicates that other factors are influencing the relationship to make it less direct. Previous studies suggest these influences might be organizational factors.
- The 2nd and 3rd quartile for the resident-to-worker ratio produced statistically significant odds ratios (OR) more often than the 1st or 4th quartile in determining the probability that the injury rate would fall within specified injury-rate quartiles. The non-linear trend indicates that the highest injury-rate facilities may not reduce injuries despite decreasing their staff ratio as there are other factors in the work environment that interfere with a linear relationship.
- The statistically significant staffing/injury-rate relationships were between direct care occupations injury-rates and the staff ratio for support staff and 'other' staff.
- Multiple regression analysis indicated that **allocating staffing to where workload is heaviest seems to result in lower injury rates for workers. Dayshift staffing as a proportion of total staffing was the largest contributor in explaining the variance in injury rates**.

Policy/Prevention Implications:

Effective injury tracking and interventions need accurate data and supervision of documentation to eliminate 'unspecified claims' by ensuring that all claims are correctly identified as to:

- Occupation of injured worker;
- Time of injury; and
- Staffing levels and workload associated with the shift/work environment where injury occurred.

The WCB database must include "time of injury" to enable linkage of injury rate to staffing variables on specific shifts.

- The ability to compare injury rates across occupational groups in a facility enables better understanding of the dynamics of care responsibilities, physical workload, injury risk and prevention strategies appropriate to each occupational group.
- The low correlation between injury rates and staffing levels within occupations indicates the possibility that other factors (such as organizational culture, communications, trust, etc...) may have equal or greater impact compared to staffing levels in determining injury rates. This suggests that there is the need for additional research that: investigates multiple factors in depth; includes site visits; and incorporates more accurate injury data (e.g. elimination of unspecified claims and provision of details as to site of injury, time of injury and occupation of injured worker).
- Site visits are essential for supplementing databases in order to eliminate 'unspecified claims' and determining other confounding factors (such as work organization factors) that might clarify the staffing/injury rate relationship.
- For facilities in the highest injury-rate category, reduction of injury rate will require multi-pronged approach involving more than just improvements in the staff ratio. On the other hand, facilities in the lowest injury-rate category can still improve their injury rate because of the direct relationship between staff ratio and injury rate.

Executive Summary:

Research Context:

The literature contains numerous studies showing a strong relationship between work environments and injury rates (Koehoorn et al., 2002; Koehoorn et al., 1999; Tummers et al., 2002). Staffing levels are a critical component of work environment (Harrington et al., 2000). Many studies have indicated that nurses from units with low staffing and poor organizational climates are generally twice as likely as nurses on well-staffed and better-organized units to report risk factors, needlestick injuries and near misses (Feuerberg, 2000; Fuortes et al., 1994; Ostry et al., 2003).

Methodology:

This report is an exploratory study doing secondary analysis of Workers' Compensation Board (WCB) injury databases linked with Labour Relations Board (LRB) staffing databases to examine the staffing/injury-rate relationship in 174 Long-Term Care (LTC) facilities across care levels and occupational groups. Care-levels ranged across: Intermediate Care only (IC), IC with Extended Care (EC), multi-level care (MC), and EC only. Generally, 'IC only' facilities comprise of residents with a range of mobility limitations (mobile to wheel-chair) but residents can transfer out of the wheelchair by themselves whereas in "EC only" facilities the residents cannot transfer out of wheelchairs without help from staff. Residents in every level of care may demonstrate some degree of dementia. MC facilities have a higher mixture of EC residents than "IC & EC" facilities.

During 1999-2001, Licensed Practical Nurses (LPNs) and Care Aides (CAs) in nursing home were generally used for the same duties, therefore, these occupations were grouped together as LPNCA for analysis. However, in some facilities LPNs and CAs had different job descriptions therefore we also disaggregated these occupations for separate analysis. Occupational data were developed for: RNs, LPNs, CAs, LPNCAs, Direct Care (RNs and LPNCAs), support staff (housekeeping, food services/dietary, laundry) and 'other' staff. Recreation Aides, Physiotherapists and Occupational Therapists were included in the "other" category along with clerical, maintenance, social workers and chaplains. Injury rates and staffing levels were calculated separately for each occupational group. Staffing is defined as the number of negotiated Full-Time Equivalent (FTE) positions agreed upon to provide 24-hour care to the residents of the facility. Staff ratios were calculated as 'residents per FTE'. Staffing data were later disaggregated by shift to differentiate facilities with the same FTEs but very different allocation of staff per shift as this relates directly to care responsibilities (workload). Injury rates were calculated for each facility and each occupational group as the average number of timeloss injuries over a 3-year period (1999-2001) divided by the respective FTEs (injuries per 100 person-years).

Statistically significant differences were examined by cross tabulation and Pearson Chi Square. Statistically significant differences within a characteristic (e.g. care levels with respect to injury rates,

profit/non-profit, chain/independent, health authority) were controlled as confounders by conducting analyses separately for each care level, profit separately from non-profit, and chain-facilities separately from independent facilities. Variables were tested for normal distribution. Injury rate, staffing, costs and timeloss variables were found to have skewed distribution. When the variable distribution was normal (parametric) we used the continuous variable for the ANOVA analysis to determine differences between categories within the variables. When the variable distribution was not normal (non-parametric) we used a rank order variable for the ANOVA analysis. We used the Kruskal-Wallis H non-parametric test for variables and then used the post-hoc ANOVA analysis to compare overall differences and the Bonferroni procedure to adjust for multiple comparisons between any two categories of a variable. Multiple regression analysis was used to determine the contribution of variables for explaining variance in injury rates. The highest and lowest staff ratio quartiles were examined according to 'all shifts' and 'dayshift'. Binary logistic regression was used to examine the staffing/injury-rate relationship to determine the probability that injury rates would fall within specific categories of injury rate: 'below the median'; in the highest injury rate group/quartile; or in the lowest injury rate group/quartile. To determine if there was a linear trend in the probability, we used staff ratio as a continuous variable. Because of the skewed distribution of injury rates for RN and LPNs, binary logistic regression was analyzed for injury-rate groups instead of using injury-rate quartiles. The lowest injury-rate group includes all the facilities with no injuries for these occupations. The highest injury-rate group includes the top third of injury rates. To get more detailed information concerning the trend in probability, we used staff ratio as a ranked variable (categorical).

Research Findings:

The 174 facilities in the study comprised of 104 'IC only', 18 'Extended Care (EC) only' and 36 combining "IC & EC'. For-profit facilities comprised the majority (58.3%) of the 'IC & EC' category. The total sample comprised of 70.1% non-profits, 7.5% of chain ownership, and 66.7% facilities with smaller than 100 beds. The levels of care varied significantly across Health Authorities especially in the multi-care (MC) category where the Interior Health Authority had 4.8% MC compared to 17.6% for the Vancouver Island Health Authority.

Care level had a strong influence on injury rates, staffing variables, costs/claim and timeloss/claim. Total injury rate [$F(3\text{-}153)=3.06$, $p=.038$] showed mean injury rates ranging from 25.52 (injuries per 100 person-years) for MC facilities to 16.80 for 'EC only' facilities.

The considerable range in variables within each occupational group as well as across care-levels demonstrated that staffing and injury rates was not adequately described by simply using 'total staff' values or by looking for a simple relationship between 'total staff' resident-to-worker ratios and injury rates. Each occupational group had a unique staffing/injury-rate relationship. The large range within

occupational groups combined with the skewed distribution make it more representative to use median values rather than mean values to describe variables.

Staff ratios (residents/FTE) represent a measure of the care responsibilities for each occupational group. However, these care responsibilities equate to different forms of workload for different occupations. For example the resident-to-RN ratio is analogous to nursing care (medical) responsibilities whereas the resident-to-CA ratio is more analogous to physical workload. The resident-to-LPN ratio is not very meaningful, as LPNs were not widely used in nursing homes during 1999 to 2001. The resident-to-LPNCA ratio was more representative of the direct care responsibilities (physical lifting and transferring of residents) of these occupations although LPNs might also have nursing responsibilities such as distribution of medication.

Dayshift resident-to-staff ratios rather than 'all-shifts' staff ratios provide the most accurate representation of actual care responsibilities since most of the care activities occur during the day. Resident-to-staff ratios corresponded inversely to facility funding levels. For example, the lowest median dayshift 'total staff' resident-to-worker ratio (2.15) was associated with the higher funded "EC only' facilities and the highest ratio (3.05) was found in the lower funded 'IC only' facilities. For every occupational group the median dayshift staff ratios were generally lowest in 'EC only' and highest in 'IC only', with the exception that MC facilities had the lowest median dayshift RN staff ratio (17.60) compared to 18.65 for 'EC only' and 23.51 for 'IC only'. Generally within the Direct Care occupations at each care-level, the CAs had the lowest staff ratio whereas RNs had the highest care responsibilities. Although the dayshift "total staff" resident-to-worker ratio decreased (from 3.05 for "IC only" to 2.15 for "EC only" as shown in Table 2) as the intensity of care increased across the care-levels, this did not result in corresponding decreases of injury rates across the care-levels. If the relationship between injury rate and the resident-to-worker ratio was simple for each occupation, we would expect to find the highest injury rates in 'IC only" facilities because this classification has the highest resident-to-worker ratio. However, it was the MC facilities that had significantly higher resident-to-worker ratios compared to any of the other care-levels (see the Bonferroni significance in Table 2). Alternatively, we would expect to find the lowest injury rates in "EC only" facilities because this classification has the lowest resident-to-worker ratio. Table 2 reveals that the lowest median injury rate occurs in EC facilities for most the occupational groups except support staff and other staff where the lowest rates were in 'IC only' facilities.

Across occupations, RNs produced the lowest mean (7.68 injuries per 100 FTEs) and median (5.36) injury rate whereas CAs had the highest median (17.61) and mean (21.00) injury rates. The lowest median occupational injury rates are generally found in 'EC only' (e.g. 4.00 for RN injury rate). The highest median injury rates were always associated with the multi-level care facilities (e.g., 7.26 for RN injury rate). Considering that MC facilities have the second highest funding compared to 'EC only'

facilities it is disturbing that MC facilities have nearly twice the injury rates (178% for total staff, 633% for LPNs, and 189% for CAs) of the EC facilities.

Multiple regression analysis revealed that staffing-related variables explained only a small proportion of variance in injury rates: 7.2% for total staff, 12.2% for RNs, and 6.9% for LPNCAs. Analysing for 'IC only' slightly increased the explanation of injury rate variance with R^2 of: 13.2% for total staff, 18.8% for RNs, and 14.7% for LPNCAs.

The broad range of staff ratios and injury rates across occupations made it necessary to stratify the staffing/injury-rate variables by occupational group. The wide range of quartile values produced different complex staffing/injury-rate relationships for each occupational group. Except for 'other staff' there were no statistically significant correlations within the same occupation between staff ratio and injury rates. However, when analysing for 'IC only', several staff ratios showed a significant correlation with injury rates for another occupation. For example, dayshift RN staff ratios did have a statistically significant correlation with LPNCA injury rate (Spearman $r = -.223$, $p < .05$) and the dayshift Direct Care staff ratio correlated significantly with RN injury rates (Spearman $r = -.225$, $p<.05$) and CA injury rates (Spearman $r = -.218$, $p<.05$). The fact that increases in the resident-to-RN ratio were associated with decreased LPNCA injury rates is surprising. It might suggest that as the care responsibilities of RNs increase, they supervise the work of LPNCAs to ensure better work practices in lifting and transferring residents. The effect of increasing care responsibilities on RN injury rates is more understandable as increased care responsibilities mean that RNs have less time allocated to lifting and transferring residents and thus less probability of incurring timeloss injuries due to MSIs. Examining correlations of injury rates with the highest or lowest staff ratio quartile showed significant correlations with either the lowest or highest quartile but never with both. These findings suggest that the staffing/injury-rate relationship is different in the lowest and highest injury-rate quartiles or groups. Logistic binary regression using staff ratio as continuous variables demonstrated a linear trend for the probability of the injury rate being in the lowest quartile or group of injury rates. This indicates that the relationship between staff ratio and injury rate is quite straightforward with increases in staff ratio having a direct effect on injury rate. Only RN and LPN injury rates showed a linear trend in the probability of the injury rate being above the median. No occupational staffing/injury-rate relationship demonstrated any linear trend in probability of being in the top group or quartile of injury rates. This latter result indicates that the staffing/injury-rate relationship is less direct in that a change in staff ratio does not lead to a direct change in injury rate. These different results between the lowest and highest injury rate categories suggest there is a threshold somewhere between them where the staffing/injury-rate relationship shifts from direct to indirect relationship between the independent variable (staff ratio) and the dependent variable (injury rate). With regard to the staffing/injury-rate relationship, the non-linear trend in probability of being in a specific injury-rate category indicates that other factors are

influencing the relationship to make it less direct. Previous studies suggest these influences might be organizational factors.

To clarify what was happening in the top and bottom injury-rate categories, we used logistic binary regression analysis with staff ratio as an ordered variable categorized from lowest to highest (e.g. 1st, 2nd, 3rd, 4th). This analysis provided more detailed information by demonstrating how the odds ratio for being in a specific injury-rate category changes with each quartile of the staff ratio. Generally, the lower staff ratios (residents/worker) are associated with the lowest injury-rate category and the higher staff ratios with facilities in the highest injury-rate category. The logistic regression analysis demonstrates that the statistically significant odds ratio (greatest impact on the probability of being in a specific injury rate category) is often in the 2nd or 3rd staff ratio quartile rather than in first or 4th quartile. When we examined care responsibilities as measured by staff ratio (residents/FTE) we found that the odds of being in the top injury-rate quartile often increased in the 3rd quartile of the staff ratio and decreased after that even though care responsibilities still increased in the 4th quartile. This suggests that some positive factors (organizational culture, communications, support, trust) moderate injury rates despite increased care responsibilities. The results do not explain which factors interfere with a direct relationship of staffing/injury-rate in the top injury-rate category.

Implications for Future Research:

Allocating staffing to areas of highest workload results in lower injury rates for workers. However, the indirect relationship between staff ratio and injury rate in the top injury-rate category suggests that for facilities to get out of this category requires a multi-component approach not only improving the staff ratio but also looking at other workplace factors (such as supportive workplace, safety culture, communications, trust) that can moderate injury risks and have greater impact on injury rates than the detrimental effect of inadequate staffing levels. Because there is a direct staffing/injury-rate relationship in the lowest injury-rate category, facilities can realize improvements in their injury-rate by reducing their staff care responsibilities to those equivalent to staff ratios in lowest quartile. Effective analysis requires accuracy of data. The large amount of ‘unspecified claims’ with respect to occupation compromised the analysis and limiting the understanding of the relationship between staffing and injury rates. Site visits and facility management follow-through on injury incidents can minimize ‘unspecified claims’ and ensure identification of time of injury and occupation are included in each claim statement. The ability to compare injury rates across occupational groups in a facility enables better understanding of the dynamics of care responsibilities, physical workload, and injury risk. Facilities can thus make informed decisions as to the occupational mix and staff level most effective for meeting the care needs of residents. Knowledge concerning the occupational dynamics relating to staffing and injury rates can facilitate the design of effective prevention strategies appropriate targeting each occupational group.

Research Problem / Context:

This study is a follow up of the study "Reducing Injuries in Intermediate Care facilities" (CAHR, 2003)[1,2] which examined facility records and WCB data to determine the relationship between work organization factors and injury rates. In the previous study, four facilities were chosen from a provincial group in the highest quartile of injury rates and four were chosen from the lowest quartile of injury rates (based on the 5-year average from 1995-99). Comparing the high injury-rate facilities HIRFs) with the low injury-rate facilities (LIRFs) provided insight concerning the factors influencing injury rates. One of the strongest relationships was found between staffing-levels and injury rates. A preliminary cost-benefit analysis for the eight facilities indicated that Intermediate Care (IC) facilities that were HIRFs might achieve cost savings resulting from reductions in injuries due to additional staffing. The current study attempts to verify these findings with a larger sample of IC facilities and a representative sample of Extended Care (EC) facilities as well as Multi-level Care (MC) facilities. If a strong relationship can be verified between staffing levels and injury rates then the nursing home sector may have a means of reducing the high injury rates prevalent in long-term care (LTC) facilities.

The literature indicates that injury rates for healthcare staff are unacceptably high. Workers Compensation Board (WCB) data in Canada[3,4] and the USA[5,6] show that injury rates in the healthcare sector and especially in the LTC sector are higher than the average injury rates inclusive of all sectors in each jurisdiction. The literature also asserts that workers in LTC facilities are at the highest risk of injury of any workers in the healthcare sector. The WCB of British Columbia (2002)[3] reported higher risk for workers in LTC (9.0 in 2001) compared to workers in acute care (7.0% in 2001). The higher injuries in LTC than in acute care, sustained

mainly by licensed practical nurses (LPNs) and care-aides (CAs), are attributed to the provision of care for more vulnerable elderly residents who require much lifting and transferring.

Leigh and Miller (1997),[5] while examining more than 400 occupations in WCB databases, showed that CAs ranked sixth of all occupations (inclusive of all sectors) with respect to total timeloss costs and ranked 20th of all occupations with respect to cost per injured worker. LPNs ranked 62nd in total annual costs and 91st in average cost per employee. RNs on the other hand ranked 29th in total costs but were in the group with the highest costs per injured worker. In a previous study in a Canadian acute care setting (CAHR, 2002), we found that LPNs combined with CAs (LPNCAs) were more likely compared to RNs to experience: any injury (1.58 times), patient-handling injury (2.08 times) and violence-related injury (3.09 times).[6] When comparing injury rates of direct care workers, Fuortes, Shi, Zhang, et al. (1994)[7] reported that the incidence of low-back injury in CAs was 3.3 higher than in RNs and LPNs. Fuortes and colleagues found that occupational duties requiring twisting and lifting increased the risk of low-back injury by 4.84 times. The more frequently residents have to be moved the greater the injury risk for staff. This risk is likely to be magnified on badly designed wards where staff do not have proper lifting equipment or are not properly trained for these tasks.

In many countries there have been many presentations to government authorities explaining that staffing levels in nursing homes are inadequate.[8,9,10,11,12,13,14] The *Report to Congress: Appropriateness of minimum nurse staffing ratios in nursing homes* (Feuerberg, 2000)[8] comprised of several sub-studies that found strong associations between low nurse staffing levels and workload, poor resident outcomes, low job satisfaction and high turnover of resident-care staff. The US government is still working on developing minimum nurse staffing

levels in nursing homes. In the American literature the term nursing staff incorporates registered nurses, licensed practical nurses and nursing assistants.

The literature contains numerous studies showing the strong relationship of work environments on injury rates. Staffing levels are a critical component of the work environment. Koehoorn et al. (2002)[15] documented the links between work environments and healthy outcomes (injury rates, burnout, job satisfaction) for workers and organizations. Koehoorn et al. (1999)[16] reported that adverse work organizational factors, design of the physical workplace, and the continual lifting of residents contribute to musculoskeletal injuries. Clarke, Sloane and Aiken (2002) [17] found that nurses from units with low staffing and poor organizational climates were generally twice as likely as nurses on well-staffed and better-organized units to experience needlestick injuries and near misses. Work organization factors include a range of variables measuring: the structure, culture and practices of the organization, staffing levels, the philosophy and state of labour-management relations, the management of occupational health and safety (OH&S) issues and the functioning of health and safety committees. Several studies reported that dysfunctional work organizations create stress that in turn leads to musculoskeletal injury and low job satisfaction.[17,18,19,20,21,22,23,24,25,26,27.28,29] All these studies were peer-reviewed and consisted of large sample sizes. A recent survey by the HEU (2000)[30] in British Columbia found that among 881 randomly surveyed HEU members, 58% felt either mentally or physically stressed at the end of the workday, “almost always” or “often.” Tummers, Landeweerd, and van Merode (2002)[31] concluded that organizational factors (such as ward characteristics, task-oriented nursing, predictability of care, co-operation, complexity of care, and flexibility of care planning) influence work characteristics (such as workload and autonomy). Thus, according to Tummers et al. (2002)[31] improvement in job satisfaction and health outcomes can only be

effectively achieved after improving organizational functioning such as staffing levels as well as improving autonomy and reducing workload.

The findings of our IC study (CAHR, 2003)[1-2] suggested that staffing level is an important organization factor for LTC in B.C. because although each facility receives equivalent global funding, each organization decides where to allocate funds. Major differences were found in extent to which facilities allocated financial resources for front line care staff. Low injury rate facilities (LIRFs) allocated more funding to front line resident handling staff compared to the high injury rate facilities (HIRFs). On average the HIRFs were staffed at the ratio of 16 residents per LPN/CA whereas LIFRs were staffed at a 12:1 ratio.

Although there is general agreement of the strong association between staffing levels, workload and injury rates [32,33,34,35] there has been negligible documentation of analysis applied to the strategy of increased staffing levels to reduce injuries in Intermediate Care facilities. Most analysis has been applied to improvements in lift mechanisms,[36] reducing specific injuries through engineering, [37] hazard prevention,[38] and improved electronic health records. [39]

Aims and objectives of the project

The objectives of this research was to determine: the relationship between staffing levels and injury rates and the feasibility of using WCB databases. This relationship was to be examined while analysing for resident care occupations (RNs compared to LPNCAs) as well as analysing for the care level mix of LTC facility. The study aimed to replicate the findings from the previous IC study by looking at a larger sample of single-site IC facilities (N=104) as well as to broaden the analysis to facilities that have several levels of care: 'IC only', 'extended care' (EC) only, 'IC with EC', and 'multi-level care' (MC). The research questions for the current study were: 1) whether the relationship between staffing and injury rate offers any practical cost-

benefit of increasing staff to reduce injuries; 2) whether the staffing/injury-rate relationship differs substantially by occupation or by category of facility.

Methodology:

This is an exploratory study doing secondary analysis of injury databases from the WCB and staffing databases from the Labour Relations Board of British Columbia. Staffing is defined as the number of the negotiated Full-Time Equivalent positions (FTEs) agreed upon to provide 24-hour care to the residents of the facility. The staffing level variable is a measure of staffing in relation to residents (e.g., FTEs per resident over the 24-hour period of care). Staffing data were later disaggregated by shift to differentiate facilities with the same FTEs that might have very different breakdown of staffing per shift and this might confound the results in comparing the association with incidents of injury. The WCB provided the following aggregated injury data for 1999-2001 for each facility by occupational group and by LTC classification: number of timeloss injuries, total timeloss days, total timeloss costs for injuries occurring during each year, and costs per injured worker. Injury incidents were not aggregated by time of injury (i.e. shift on which the injury occurred). Therefore incidents could not be related to staffing levels on particular shifts. However, we obtained shift-staffing levels to represent a measure of work organization that describes how facilities allocate workload.

After the appropriate ethics approval the research team obtained a province-wide staffing database for 2001 from the Labour Relations Board (LRB) and Hospital Employees' Union (HEU) Essential Services Agreement. In addition, the Vancouver General Hospital researchers from the "Does Ownership Matter" (DOM) project provided registered nurse staffing data and support staffing data for all available facilities for those BC facilities represented by the British

Columbia Government Employees' Union (BCGEU). The WCB of BC provided a province-wide injury database for 1999-2001.

The merged databases provided sub-sector information: 1) for occupational groups consisting of registered nurses (RNs), licensed practical nurses (LPNs) and care-aides (CAs) as well as support staff (housekeeping, food services/dietary, laundry); and 2) for the classification of long-term care (LTC) facilities grouped into "IC only" (IC), "EC with IC", "EC only" and "MC" facilities. The staffing database was verified for classification of facility as well as legal name to ensure that staffing could be linked to a single site employer number and location code matching the WCB database. Because of employer merges and regionalization, much data has been aggregated across multiple facility sites thus making it difficult to have a clear representation of the relationship between staffing levels and injury rates.

The WCB database was also examined to ensure that legal names match employer accounts with single-site injury data to ensure the accuracy of the linkage with staffing data. The occupational group data were identified according to the WCB codes. Occupations were grouped as: RNs, LPNs, CAs, and support staff. Recreation Aides as well as Physiotherapists and Occupational Therapists were included in the "Other" category. Because LPNs and CAs were often used interchangeably, we analysed data for the combined group as LPNCAs. We also analysed the staffing/injury-rate relationship combining RNs, CAs and LPNs as Direct Care.

From Ministry of Health sources we obtained a list of 306 LTC facilities in British Columbia. We excluded 113 because there were no staffing data for them registered with the Labour Relations Board (LRB). The excluded facilities were primarily 'for-profit' non-unionized facilities. Three non-profit facilities (2 EC and one 'IC & EC') were excluded because they were attached to acute care hospitals and the injury data could not be differentiated between the staff

who only worked in long-term care, those only working in acute care, and those working in both (mainly support staff). From the remaining 190 facilities, 16 were excluded because they did not have three consecutive years of injury data for the period 1999-2001. This last eliminated group was predominantly in the '50-99 bed' range of Intermediate Care facilities.

Analytical Procedure:

1. Calculate the injury and staffing variables for the three-year period 1999-2001.
2. For each occupational group (all occupations, RNs, LPNs, CAs, LPNCAs, Direct Care staff and Support Staff) examine injury rates according to: care-level, number of beds in the facility, impact of support staff, type of facility (profit/non-profit; single site versus chain), staffing (FTE/resident), staffing ratio (residents/FTE). Staffing and staffing ratio are examined for 'all shifts' and 'dayshift'
3. Examine the (all shifts and dayshift) odd ratio of staffing and staffing ratio for having injury rates in various categories ('at or above the median', 'highest quartile', 'lowest quartile').
4. Take steps 2 & 3 for each occupational group to examine: cost per claim, percentage of total costs, timeloss per claim, and percentage of total timeloss.

<u>Computation of variables:</u>

Injury rates were calculated as the average of the total injury claims over three year (for each occupational group) divided by the respective FTEs for that occupational group. Staffing levels (FTE/resident) are calculated from the staffing database (which includes the number of residents at each facility). Dayshift staffing levels were developed as dayshift FTEs/resident. Staff ratios were obtained by dividing the number of residents by the total FTEs (residents/FTEs)

appropriate for all shifts and dayshift by dividing the number of residents by the FTEs available for the specific occupational groups. Timeloss per claim and costs per claim for each occupational group were obtained by dividing the respective total 3-year timeloss or 3-year costs by the total claims during the 3-year period. If the number of single site linkages were too small in any classification (e.g. the 'EC & IC' classification, and the 'MC' classification) they were used to describe the whole sample but not be used in the analysis of the relationship between staffing variables and injury rates.

Statistically significant differences in characteristics of facilities were examined by cross tabulation and Pearson Chi Square. When there were statistically significant differences within a characteristic (e.g. care levels with respect to profit/non-profit, chain/independent, health authority) then that characteristic was controlled as a confounder by doing analysis separately for each category of: care-level, profit/non-profit, and chain/independent facilities.

The variables were tested for normal distribution. The Kruskal-Wallis H non-parametric tests and then post-hoc ANOVA analysis were used to compare overall. The Bonferroni procedure was used to adjust for multiple comparisons between any two categories of a variable. When the variable distribution was not normal (non-parametric) we used a rank order variable for the ANOVA analysis. When the variable distribution was normal (parametric) we used the continuous variable for the ANOVA analysis. Multiple regression analysis was used to determine the contribution of independent variables to explain the variance in injury rates (dependent variable).

Results

The 174 facilities consisted of: 104 ‘IC only’, 36 ‘IC & EC’, 16 MC and 18 ‘EC only’ facilities (see Table 1). Non-profits comprised the majority of facilities at every care-level except for ‘IC & EC’ where for-profit facilities comprised 58.3% of that category. Across care-levels, ‘for-profit’ comprised 44.2% in ‘IC only’, 40.4% in ‘IC & EC’, 11.5% in MC and only 3.8% in ‘EC only’ (row percentages not shown in Table 1). Facilities with less than 100 beds comprised 66.7% of the total sample whereas only 7.5% of the total sample belonged to chain ownership. Chain ownership varied across care-levels with the majority (61.5%) operating as ‘IC & EC’, 23.1% as ‘IC only’, 15.4% as MC and none as ‘EC only’ (row percentages not shown in Table 1). There was no significant difference in facility size (total number of beds) across care-levels. Although the total staff ratio varied significantly by size of facility [$F(3,153)=3.52$, $p=.017$] there were no statistically significant differences when analysing each care-level separately.

Characteristics of Staffing and Injury Rates Across Care-Levels

Funding is allocated according to care-level in ascending order as: ‘IC only’, ‘IC & EC’, ‘Multi-level’ (MC), and ‘EC only’. Care-level (analogous to care requirement of residents) has a strong association with injury rate and resident-to-worker ratio. Table 2 shows: the significant differences of variables across care-levels; the Bonferroni probability between any two care-levels; as well as the range of mean and median values for respective variables within occupational groups. The mean ‘total staff’ injury rate ranged from 25.52 injuries per 100 person-years for MC facilities to 16.80 for ‘EC only’ with Bonferroni significance between ‘IC only’ and MC facilities ($p=.023$).

The considerable range in variables within each occupational group as well as across care-levels demonstrated that staffing and injury rates was not adequately described by simply using 'total staff' values or by looking for a simple relationship between 'total staff' resident-to-worker ratios and injury rates. Each occupational group had a unique staffing/injury-rate relationship. The large range within occupational groups combined with the skewed distribution make it more representative to use median values rather than mean values to describe variables.

Median Staff Ratios (Residents/FTE) Across Care-levels

Staff ratios (residents/FTE) represent a measure of the care responsibilities for each occupational group. These care responsibilities equate to different forms of workload for different occupations. For example the resident-to-RN ratio is analogous to nursing care (medical and supervisory) responsibilities whereas the resident-to-CA ratio is more analogous to physical workload. The resident-to-LPN ratio is not descriptive of LPN care responsibilities because LPNs were not widely used in nursing homes during 1999 to 2001 and their job description varied across facilities with some used interchangeably with CAs while others were given nursing responsibilities such as distribution of medication. The resident-to-LPNCA ratio was more representative of the direct care responsibilities (physical lifting and transferring of residents) of these occupations.

Dayshift resident-to-staff ratios rather than 'all-shifts' staff ratios provide the most accurate representation of actual care responsibilities since most of the care activities occur during the day. Therefore in Table 2 we only present dayshift resident-to-staff ratios across care-levels although the F-value results for the 'all-shifts' staff ratio were also statistically significant. Resident-to-staff ratios corresponded inversely to facility funding levels. For example, the lowest median dayshift 'total staff' resident-to-worker ratio (2.15) was associated with the higher

funded “EC only’ facilities and the highest ratio (3.05) was found in the lower funded ‘IC only’ facilities. For every occupational group the median dayshift staff ratios were generally lowest in ‘EC only’ and highest in ‘IC only’, with the exception that MC facilities had the lowest median dayshift RN staff ratio (17.60) compared to 18.65 for ‘EC only’ and 23.51 for ‘IC only’. Generally within the Direct Care occupations at each care-level, the CAs had the lowest staff ratio whereas RNs had the highest care responsibilities.

Median Dayshift Staff As a Proportion of ‘All-Shifts’ Staff Across Care-levels

Facilities can be differentiated by how they allocate their staff within the 24-hour care requirement. There was wide variation across occupations but little variation across care-levels in the proportion of staff on dayshift. Generally the ‘Direct Care’ occupations had a median ranging from 45.5 to 52.7% of their staff on dayshift across the care levels. The proportion of ‘total staff’ on dayshift compared to ‘all-shifts’ is higher (median ~60%) than the Direct Care proportion because ‘other staff’ (median ~72.0-89.5%) and support staff (median ~81.5-86.7%) are predominantly allocated on dayshift.

Median Injury Rates (Time-loss Injuries Per 100 Person-Years) By Care-level

Across care-levels, the staffing/injury-rate relationship may be confounded by the intensity of care required by residents at each care-level. On a continuum of care intensity, the residents in “IC only’ facilities generally require the least intensity of nursing care followed by ‘IC & EC’, ‘multi-level’ and ‘EC only’ respectively. Although the dayshift “total staff” resident-to-worker ratio decreased (from 3.05 for “IC only” to 2.15 for “EC only” as shown in Table 2) as the intensity of care increased across the care-levels, this did not result in corresponding

decreases of injury rates across the care-levels. If the relationship between injury rate and the resident-to-worker ratio was simple for each occupation, we would expect to find the highest injury rates in 'IC only" facilities because this classification has the highest resident-to-worker ratio. However, it was the MC facilities that had significantly higher resident-to-worker ratios compared to any of the other care-levels (see the Bonferroni significance in Table 2). Alternatively, we would expect to find the lowest injury rates in "EC only" facilities because this classification has the lowest resident-to-worker ratio. Table 2 reveals that the lowest median injury rate occurs in EC facilities for most the occupational groups except support staff and other staff where the lowest rates were in 'IC only' facilities. Table 3 shows the detailed range of mean and median injury rates by occupational group. In the total sample (all care-levels included) RNs produced the lowest mean (7.68 injuries per 100 FTEs) and median (5.36) injury rate whereas CAs had the highest median (17.61) and mean (21.00) injury rates. RNs and LPNs generally had lower timeloss injury rates than support staff and other staff. The lowest median injury rates are generally found in 'EC only' (e.g. 4.00 for RN injury rate). The highest median injury rates were always associated with the multi-level care facilities (e.g., 7.26 for RN injury rate). Considering that MC facilities have the second highest funding compared to 'EC only' facilities it is disturbing that MC facilities have nearly twice the injury rates (178% for total staff, 633% for LPNs, and 189% for CAs) of the EC facilities.

Percentage of claims across occupations

There was considerable variation within occupations regarding the proportion of occupational claims to total claims. LPNs represent the lowest proportion of total claims (mean of 2.6% and median of 0.0%), compared respectively to: 'other' staff (5.7% and 3.3%), RNs (6.7% and 5.0%), support staff (19.8% and 19.1%) and CAs (mean of 51.5% and median of

51.3%). Analysing by separate care-level did not change the relative proportions of claims across occupations. Direct Care occupations (LPN, CA, and RNs) comprised 60.7% of the total timeloss injury claims in the total sample and 60.0% when considering 'IC only'. The number of 'unspecified claims' varied substantially (ranging from 0% to 42.86% of the total claims) across the sample as well as when selecting for "IC only'. Unspecified claims produce some errors in calculating any occupational injury rates as these unspecified claims may actually be distributed evenly across the occupations (providing the least error) or belong to one particular occupation (producing the largest error).

Contribution of variables explaining the variance in injury rates:

Multiple regression analysis revealed the impact of the various confounding variables in explaining variance of injury rates. Staffing-related variables explained only a small proportion of variance in injury rates: 7.2% for total staff, 12.2% for RNs, and 6.9% for LPNCAs. Analysing for 'IC only' slightly increased the explanation of injury rate variance with R^2 of**:** 13.2% for total staff, 18.8% for RNs, and 14.7% for LPNCAs. The R^2 did not change significantly with the inclusion of: unspecified claims as a percentage of total claims; dayshift Direct Care (RN and LPNCA) FTEs as a percentage of all-shift FTEs; dayshift Direct Care FTEs, total beds, health authority; for-profit facilities; and level of care. Unspecified claims as a percentage of total claims had the largest impact (R^2 =.029) on the 'total staff' injury rate followed closely by 'dayshift FTEs as a percentage of total FTEs'. When selecting for 'IC only' the impact of unspecified claims on 'total staff' injury rate was not as strong as the contribution (R^2 =.052) of dayshift Direct Care FTEs. Dayshift as a percentage of 'all-shifts' Direct Care FTEs had the greatest R^2 change for RNs (.072), LPNCAs (.026), and Direct Care (.029) injury rates respectively. When analysing for 'IC only', the R^2 change for RN injury rates was greatest

(.068) when considering Health Authority and for-profit facilities. For 'IC only' the R^2 change for LPNCA injury rates was greatest (.058) for dayshift as a percentage of 'all-shifts' Direct Care FTEs. In addition, the R^2 change for Direct Care injury rates was greatest when considering dayshift LPNCA FTEs and dayshift RN FTEs (.054).

The Staffing/injury-rate Relationship

Each occupational group had unique broad ranges for injury rate quartiles (Table 3) and staffing variable quartiles (Table 4). Because of these broad occupational ranges, total staff injury rates and total staff resident-to-worker ratios could not adequately represent all the staffing-injury relationships and thus it was necessary to stratify the staffing/injury-rate variables by occupational group. This wide range of quartile values produced different complex staffing/injury-rate relationships for each occupational group. The injury rate distribution was very skewed, for example, the second quartile of LPN and RN injury rates included 0.00 injuries per 100 person-years for many of the care-levels.

Correlation between injury rates and resident-to-worker ratios (Table 5)

Except for 'other staff' there were no statistically significant correlations within the same occupation between staff ratio and injury rates (see Table 5A). However, when analysing for 'IC only', several staff ratios showed a significant correlation with injury rates for another occupation. For example, dayshift RN staff ratios did have a statistically significant correlation with LPNCA injury rate (Spearman $r = -.223$, $p < .05$) and the dayshift Direct Care staff ratio correlated significantly with RN injury rates (Spearman $r=-.225$, $p<.05$) and CA injury rates (Spearman $r=-.218$, $p<.05$). This might indicate that as the care responsibilities of RNs increase, they supervise the work of LPNCAs to ensure better work practices in lifting and transferring

residents. The effect of increasing care responsibilities on RN injury rates is more understandable as increased care responsibilities mean that RNs have less time allocated to lifting and transferring residents and thus less probability of incurring timeloss injuries due to MSIs. Table 5B indicates the statistically significant correlations between resident-to-staff ratios and injury rate quartiles. The staff ratio correlates significantly with either the lowest injury rate quartile or the highest injury rate quartile but never with both quartiles. These findings suggest that the staffing/injury-rate relationship is different in the lowest and highest injury-rate quartiles or groups. Because of the skewed distribution of injury rates for RN and LPNs, binary logistic regression was analysed for injury-rate groups instead of using injury-rate quartiles. The lowest injury-rate group includes all the facilities with no injuries for these occupations. The highest injury-rate group includes the top third of injury rates.

Staff ratio as continuous variables:

Curve estimate plots and binary logistic regression can provide further detail concerning the staffing/injury-rate relationship across the range of the variables. Examination of curve estimate plots indicated that there was no simple linear relationship between staff ratio and injury rate for any of the occupational groups. Binary logistic regression (Table 6) with the resident-to-worker level (staff ratio) as a continuous variable shows a linear trend in the probability of the injury rate being in specific injury rate categories: ‘above the median’; ‘in highest injury rate quartile’; ‘in the highest injury rate group’; ‘in the lowest injury rate quartile’; or ‘in the lowest injury rate group’. For non-parametric distributions such as RN and LPN injury rates, the binary logistic regression used the staff ratio as a continuous ranked variable (e.g., 1, 2, 3, 4).

Logistic binary regression using staff ratio as continuous variables demonstrated a linear trend for the probability of the injury rate being in the lowest injury-rate quartile or group. This indicates that the relationship between staff ratio and injury rate is quite straightforward with increases in staff ratio having a direct effect on injury rate. Only RN and LPN injury rates showed a linear trend in the probability of the injury rate being above the median. No occupational staffing/injury-rate relationship demonstrated any linear trend in probability of being in the top group or quartile of injury rates. The staffing/injury-rate relationship is less direct in the highest injury-rate category indicating that a change in staff ratio does not lead to a direct change in injury rate. These different results between the lowest and highest injury rate categories suggest there is a threshold somewhere between them where the staffing/injury-rate relationship shifts from a direct to an indirect relationship between the independent variable (staff ratio) and the dependent variable (injury rate). With regard to the staffing/injury-rate relationship, the non-linear trend in probability of being in a specific injury-rate category indicates that other factors are influencing the relationship to make it less direct. Previous studies suggest these influences might be organizational factors. [1,2,15,16]

The fact that staff ratio produced no statistically significant linear trend in the probability of being in the highest injury-rate category, indicates a non-linear staffing/injury-rate relationship (curve estimate plots indicate it might be cubic). It was noted that within the same occupation there was no significant linear relationship between staff ratio and injury rate except for RN injury rates in the lowest injury-rate category. For the whole sample and for ‘IC only’ a unit increase in dayshift resident-to-RN ratio increased the probability of the injury rate being in the lowest injury group.

Table 6 shows that the linear trend in the probability of the RN injury rates 'being above the injury-rate median' was limited to the 'all-shifts' Direct Care staff ratio. A unit increase in resident-to-staff ratio decreases by (1-.35) 65% the probability that the RN injury rate will be above the median. There was no linear trend in the probability of any occupational group being in the highest injury-rate category. Table 6 also shows that the 'total staff' injury rate had a linear association between the dayshift resident-to-RN ratio and the probability of being in the lowest injury-rate category. For the total sample, a unit increase in dayshift Direct Care staff ratio increases the probability of the total injury rate being in the lowest quartile by (1.35-1) 35%.

The RN injury rate showed a linear trend between dayshift RN staff ratios and the probability of being in the lowest injury group. A unit increase in dayshift resident-to-RN ratio would increase the probability of being in the lowest injury group by (1.04-1) 4%. At first glance this runs counter to the expectation that an increased workload (higher resident/FTE ratio) would increase injury risk. However, as mentioned previously, this negative correlation is due to the RN job description giving priority to medical/supervisory tasks as the care responsibilities increase, thus a unit increase in RN staff ratio means that the RNs are less at risk for incurring MSI timeloss injuries. Dayshift staff ratios were very prominent amongst statistically significant odds ratios. Only the RN injury rates had a statistically significant relationship with the resident-to-worker ratio in the same occupation.

Staffing as ordered variables from lowest to highest quartile:

More detailed analysis of the staffing/injury-rate relationship was possible with binary logistic regression by using the staff ratio as a categorical (ordered) variable from lowest to highest quartile. Injury rates for total staff as well as each individual Direct Care occupation were analyzed with the all-shifts and dayshift staff ratios for each occupational group. Analysis was

conducted for the total sample (inclusive of all care-levels) as well as selecting for 'IC only' facilities. The logistic regression analysis demonstrates that the statistically significant odds ratio (greatest impact on the probability of being in a specific injury-rate category) is more often in the 2nd or 3rd staff ratio quartile rather than in 1st or 4th quartile. This indicates that as the resident-to-worker ratio increases, the probability of being in a specific injury rate quartile does not increase/decrease linearly.

Table 7 shows mixed trends, depending on whether the injury-rate is categorized as 'above the median', 'in highest category' or 'in lowest category'. Different occupational injury rates had differing patterns in their relationship with quartile staff ratios. The probability of the injury-rate 'being above the median', generally increased with each unit increase of staff ratio regarding injury rates for: total staff, CAs, LPNCAs and Direct Care staff. However, the exception occurred for RN injury rates were a unit increase in staff ratio decreased the probability of the RN injury rate being above the RN median injury rate. The same exception occurred for the highest injury-rate category. This suggests that the RN staff ratio is confounded by factors affecting job description as the staff ratio represents care responsibilities rather than physical workload and as such is less directly related to RN injury.

The probability trend of being in the lowest injury-rate category was even more mixed than for the 'above median' or in the highest injury-rate category. The 'total staff', LPN and RN injury-rates trends were in the opposite direction than expected. With each increase in staff ratio one would expect a decrease in the probability of being in the lowest injury-rate category. As mentioned previously, both the RN and LPN staff ratios have a negative correlation with their occupational injury rate such that an increase in care responsibilities actually decreases the risks of incurring musculoskeletal timeloss injuries. The 'total staff' injury rates indicated a mixed

staffing/injury-rate relationship because of the contribution of RNs and LPNs in the total staff variables.

Staffing levels and injury rates impacting the same occupation or impacting another occupation

In Table 7 there were only two significant staffing/injury-rate relationships within the same occupation: CA injury rates and CA staff ratios in the highest injury-rate category; and the 'total' injury rate and 'total' staff ratio in the lowest injury-rate category. In all other cases the significant staffing/injury-rate relationships were across occupational groups. In most cases the occupational injury rates was significantly impacted (increased) by an increase in the staff ratios of support staff, 'other staff' and 'total staff'.

Only in a few cases were RN, LPN, CA, LPNCA or Direct Care injury rates affected by staff ratios in the other direct care occupations. The LPNCA all-shifts staff ratios of the 2nd quartile had maximum impact (OR=0.20, $p<.01$) in decreasing the probability (by 80%) that RN injury rates would be above the median. This suggests that for each unit increase in LPNCA staff ratio the RN injury rate would have an 80% decrease in probability of being above the median. The same pattern held true for RN injury rates in the highest injury-rate category, increased staff ratios for LPNs, CAs and LPNCAs were associated lower probability that RN injury rates would be found in the highest injury-rate category. Similarly, an increase in LPNCA staff ratio was associated with increased probability that RN injury rates would be in the lowest injury-rate category. These occupations have greater impact on RN injury rate than does the RN staff ratio. There is no clear explanation why increased LPNs, CAs or LPNCAs care responsibilities are associated with lower RN injury rates. The interaction between direct care occupations produced mixed results, with an increase in staff ratio sometimes resulting in an increase or decrease in injury rate for the other occupation. This study cannot explain the interaction amongst direct care

occupations but the different job description and care responsibilities of these occupations may be the cause for the complex staffing/injury-rate relationships. Further study is warranted to clarify the effect of staff mix with regard to the staffing/injury-rate interaction.

These results indicate that there are confounding factors regarding the interaction of care responsibilities with organizational factors, staff-mix, nursing responsibilities and their interaction with injury rates. Dayshift staff ratio variables were more likely to produce statistically significant probabilities for the staffing/injury-rate relationship. This suggests that the extent facilities allocate staffing to shifts of maximum workload has definite impact for reducing injury rates for facilities in the lowest injury rate quartile. The allocation of staffing resources is a measure of organizational culture and beyond the purview of this study.

Implications for Future Research on Occupational Health

Allocating staffing to where workload is heaviest seems to result in lower injury rates for workers. Dayshift staffing as a proportion of total staffing was the largest contributor in explaining the variance in injury rates. However, this study found a minimal (weak) relationship between occupational injury rates and occupational staffing levels. In the previous study [1,2] the relationship between LPNCA staff level (FTEs/resident) showed a strong association with LPNCA injury rates (see Figure 1). The relationship between staffing levels (the number of FTEs per resident) and timeloss injury rates at the facility level were examined as a scatter plot showing a relationship between the two for each occupational group (RN vs. LPN/CA vs. support staff) and for each classification of LTC facility. The 104 data points for Intermediate Care facilities had a potential to provide a clearer picture of the relationship in the scatter plot that the previous 8-facility study. Unfortunately we did not obtain a clear picture (see Figure 2).

The same cost-analytical procedure was repeated for each facility classification and each occupational group and no significant correlation was found between staffing ratio and injury rate when controlling for occupational group and classification of facility. In each case we were able to determine that injury rates and staffing level in any specific occupational group within a particular facility classification had little or no relationship to each other.

The wide variation in staffing across facilities, within care-levels and within occupations, suggests that organizational factors other than the intensity of resident care needs are involved in staffing decisions. Lower resident-to-worker ratios were associated with increased probability that facilities would be in the lowest injury rate quartile. The staffing-injury relationship is complicated by organizational factors (intensity of care, staff mix, and organizational culture) all known from other studies to impact on injury rates. [1,8-9] It is unclear why a median of 17.6% of CA FTEs experienced timeloss injuries whereas only 7.9% of LPNs did so. Site visits at some facilities indicated that LPNs and CAs were used interchangeably by facilities. However, discussions with union representatives indicated that province-wide there was much variability in this procedure as more and more LPNs were being employed to distribute medication and take on more nursing responsibilities rather than exclusively doing CA duties such as lifting and transferring of residents. As reported by Fuortes et al. (1994), the smaller proportion of time that LPNs are allocated for lifting and transferring residents compared to CAs may explain the different injury rates. It was disconcerting to find that more than half the facilities (median) had CAs with injury rates greater than 17.6 timeloss injuries per 100 FTEs. Regardless of the explanation, the fact that Care Aides have the highest injury rates of the nursing home occupations indicates that prevention strategies should be targeted towards this occupational group.

The binary logistic regression did however indicate that the staffing/injury-rate relationship is most likely to be represented by a linear probability trend in the lowest injury-rate category but a non-linear probability trend in the highest injury-rate category. This indicates that facilities in the lowest injury-rate category can work to reduce occupational injury rates by improving staff ratios because there is a direct relationship between staff ratios and injury rates for them. Alternatively, for facilities in the highest injury-rate categories, it is recommended that they try a multi-component approach to reducing occupational injury rates because in the highest injury-rate category the staffing/injury-rate relationship is more indirect and improvements in staff ratios will not necessarily lead to corresponding reductions of injury rates. The interaction of different occupational staff ratios on other occupations injury rates suggests that staff mix and organizational factors (such as safety culture, organizational support, improved communications) may have greater effect on reducing injury rates than simply decreasing care responsibilities by increasing the number of staff.

The ability to compare injury rates across occupational groups in a facility enables better understanding of the dynamics of workload, injury risk and facilitates the design of effective prevention strategies appropriate to each occupational group. Effective analysis requires accuracy of data. The large amount of ‘unspecified claims’ with respect to occupation resulted in compromising the analysis and limiting the understanding of the relationship between staffing and injury rates. Future research requires that the WCB database eliminate the incidence of ‘unspecified claims’. Site visits can minimize ‘unspecified claims’ by linking claims statements with the occupation of the injured worker. Facility management follow-through on injury incidents could ensure that time of injury is included in the claim statement. This would greatly

facilitate the linkage of injury to the appropriate staffing workload of the shift on which the injury occurred.

Policy and Prevention:

Injury rates vary substantially according to the intensity of care needed by residents. Because the generic care-level classification is not effective, some universal measure of resident care requirements is needed to compare actual facility intensity of care workloads. Facilities need to measure the intensity of care requirement in their facility to determine the most appropriate staff mix and staff ratios required to meet residents' care needs while still ensuring the safety of their staff. Finding that Care Aides have the highest injury rates, costs/claim and timeloss/claim indicates that policy and prevention strategies should be targeted towards decreasing workload and improving the work environment for this occupational group.

Managers must ensure that injury incidents are tracked effectively to ensure that documentation identifies the occupation of the worker, the time of injury, and staffing levels in place at the time and place of the injury, and environmental factors contributing to the injury. In this way, injuries can be linked more effectively to staffing levels, workload and other organizational factors contributing to risk of injury.

This research is the first to shed light on the non-linear relationship of staffing and injury rates for facilities in the highest injury-rate category. The results suggest that below a specific injury-rate threshold, other organizational factors combine with the poor staffing levels to exacerbate the injury rates for direct care occupations. Organizational factors such as high workload, poor management support of workers, ineffective communications channels and

detrimental practice environments magnify risk factors and have greater impact on injury rates than staffing levels by themselves.

Dissemination / Knowledge Transfer

Research results should be circulated to: managers of long-term care facilities, relevant unions, Occupational Health and Safety (OH&S) committees at the health authority level as well as at the facility level, as well as to academic institutions and government institutions (Workers' Compensation Boards across Canada and in the USA) involved in occupational health and safety research.

There are a large number of specific methods that will be utilized to disseminate the research findings. First, the results of the study will be placed on the Occupational Health and Safety Agency for Healthcare website. Secondly, results will be distributed through the newsletters of the partners undertaking this study (HEU, HSA, BCNU, Health Employers' Association, Health Authorities). A third strategy is to present findings to conferences on healthcare, health management, occupational health and safety, gerontology, etc.. Finally, the researchers will pursue publishing the study in the peer-reviewed journal *Nursing Research* as it follows up on a study published in that journal.

References

1. Yassi, A., Cohen, M., Cvitkovich, Y., Park, I., Ratner, P. A., Ostry, A. S., Village, J. & Pollak, N. (2004). Factors associated with staff injuries in Intermediate Care facilities in British Columbia, Canada. Nursing Research, 53(2), 87-98.

2. CAHR (2003). *Reducing injuries in Intermediate Care facilities*. A Community Alliance for Health Research (CAHR) project funded by the Canadian Institute of Health Research and the Workers Compensation Board (WCB) of British Columbia. Available at the Occupational Health and Safety Agency for Healthcare (OHSAH) website URL:http://www.ohsah.bc.ca/media/ReducingInjuries.pdf.

3. Workers' Compensation Board of British Columbia. 2000. Healthcare Industry: Focus Report on Occupational Injury and Disease. WCB of British Columbia, Vancouver, BC.

4. Workers' Compensation Board (WCB) of British Columbia. Fact sheet – Healthcare Projects Form held at Vancouver, November 26th, 2002.

5. Leigh, P., & Miller, R. Ranking occupations based upon the cost of job-related injuries and diseases. *The Journal of Occupational and Environmental Medicine (JOM)*, 1997; 39(12):1170-1182.

6. Fuortes, LJ., Shi, Y., Zhang, M., Zwerling, C., & Schootman, M. Epidemiology of back injury in university hospital nurses from review of workers' compensation records and case-control survey. *Journal of Occupational Medicine*. 1994; 36:1022-1026.

7. CAHR (2002). *Caring for the caregivers of "Alternative Level of Care" (ALC patients: The impact of healthcare organizational factors in nurse health, well-being, recruitment and retention in the South Fraser Health Region of British Columbia*. A Community Alliance for Health Research (CAHR) project funded by the Canadian Institute of Health Research.

Available at the Occupational Health and Safety Agency for Healthcare (OHSAH) website URL:http://www.ohsah.bc.ca/media/ALC_Final%20_Report.pdf.

8. Feuerberg, M. *Report to Congress: Appropriateness of minimum nurse staffing ratios in nursing homes*. Baltimore (MD); Health Care Financing Administration (HCFA); July 20, 2000.

9. Harrington, C., Kovner, C., Mezey, M., et. al. Experts recommend minimum nurse staffing standards for nursing facilities in the U.S. *Gerontologist*, 2000; 40: 5-16.

10. Foley, M. Testimony of the American Nurses Association (ANA) before the (Subcommittee on Labour, Health and Human Services, Education and related Agencies Committee on Appropriations) United States Senate on resident safety and medical records. Presented on December 13, 1999.

11. Worthington, K. Testimony of the American Nurses Association (ANA) on OSHA's Proposed Ergonomics Standard before the (Subcommittee on Employment, Safety, and Training, Committee on Health, Education, Labour and Pensions) United States Senate, July 13, 2000.

12. Australian Nursing Federation. Submission to the Productivity Commission Inquiry into nursing home subsidies, September 21, 1998.

13. Kempski, A. *Market forces, cost assumptions, and nurse supply: Considerations in determining appropriate nurse to resident ratios in hospitals and nursing homes.* Service Employees International Union (SEIU) Nurse Alliance Official submission to California Department of Health Services comments on Licensed Nurse to resident ratios. Washington, December 2002.

14. American Nurses Association (ANA). Principles for nurse staffing.

URL:www.nursingworld.org: 2003.

15. Koehoorn, M., Lowe, GS., Kent, VR., Schellenberg, G., & Wagar, TH. Creating high-quality health care workplaces: Canadian Policy Research Networks (CPRN) discussion paper no. W/14, 2002.
16. Koehoorn, M., Kennedy, S., Demers, P., Herzman, C., & Village, J. *Musculoskeletal injuries among health care workers*. Vancouver, British Columbia: Workers' Compensation Board of British Columbia, 1999.
17. Clarke, S. P., Sloane, D. M., & Aiken, L. M. Effects of hospital staffing and organizational climate on needlestick injuries to nurses. American Journal of Public Health; 2002; 92: 1115-1119.
18. Shannon, H. S., Robson, L. S., & Sale, E. M. (2001). Creating safer and healthier workplaces: Role of organizational factors and job characteristics. *American Journal of Industrial Medicine*, 2001; 40:319-334.
19. Lowe, G. S. Healthy workplace strategies: Creating changes and achieving results. Report prepared for the Workplace Health Strategies Bureau, Health Canada, January 2004. Downloaded from www.cprn.ca/en/doc.cfm?doc=536.
20. Lowe, GS. High-quality healthcare workplaces: A vision and action plan. *Hospital Quarterly*, Summer, 2002; 49-56.
21. Elovainio, M., Kivimaki, M., & Vahtera, J. Organizational justice: Evidence of a new psychosocial predictor of health. *American Journal of Public Health*, 2002; 92(1):105-108.
22. Shain, M. The fairness connection. *OH & S Canada*, 2000; 16(4):22-28.
23. Morgan, DG., Semchuk, KM., Stewart, NJ., & D'Arcy, C. Job strain among staff of

rural nursing homes: A comparison of nurses, aides, and activity workers. *J Nurs Adm*, 2002; 32(3):152-161.

24.Seago, JA., & Faucette, J. Job strain among registered nurses and other hospital workers. *J Nurs Adm*, 1997; 27(5):19-25.

25. Bru, E., Mykletun, R. J, & Svebak, S. Work-related stress and musculoskeletal pain among female hospital staff. *Work & Stress*, 1996; 10:309-321.

26. Lagerstrom, M. H., Hansson, T., & Hagberg, M. Work-related low-back problems in nursing. *Scandinavian Journal of Work Environment and Health*, 1998; 24:449-464.

27. Sauter, SL., Lim, SY., & Murphy, LR. Organizational Health: A new paradigm for occupational stress research at NIOSH. *Occupational Mental Health*, 1996; 4(4):248-254.

28. Shain, M. Stress and satisfaction. *OH & S Canada*,1999; 15(3):38-47.

29. Shamian, J., O'Brien-Pallas, L., Kerr, M., Koehoorn, M., Thomson, D., & Alksnis, C. *Effects of job strain, hospital organizational factors and individual characteristics on work-related disability among nurses*. Report submitted to the Workplace Safety and Insurance Board (WSIB) of Ontario, October 31, 2001.

30. Hospital Employees' Union. Province-wide survey of Hospital Employees' Union (HEU) members during 2000.

31. Tummers, G. E. R., Landeweerd, J. A., & van Merode, G. G. Organization, work and work reactions: A study of the relationship between organizational aspects of nursing and nurses' work characteristics and work reactions. *Scandinavian Journal of Caring Sciences*, 2002; 16(1):52-58.

32. Joint Commission on Accreditation of Healthcare Organizations. *Healthcare at the*

crossroads: Strategies for addressing the evolving nursing crisis. **www.jcaho.org**: 2000.

33. Royal Society for the Prevention of Accidents (RoSPA). *Safer People Handling*: *Preventing back pain and injury in the health and care sectors*. A report of the 'People Handling Summit" convened by RoSPA on October 2000 and background papers. www.rospa.org.uk: 2000.
34. The American Nurses Association (ANA). The American Nurses Association's response to the Agency for Health Care Policy and Research's proposed nursing research agenda. www.nursingworld.org: 1996.
35. Ontario Association of Non-profit Homes. *The professional care team in long term care: A discussion paper*. Ontario Association of Non-Profit Homes & Services For Seniors: 2000.
36. Bielecki, JT. Dimensions of care. *Occupational Health Tracker*, 2002; 5(2), Summer. www.systoc.com.
37. Whitby, R.M., & McLaws, M-L. (2002). Hollow-bore needlestick injuries in a tertiary teaching hospital: Epidemiology, education and engineering. *MJA*, 2002; 177: 418-422.
38. TriHealth Corporate Health Services (2003). Ergonomics for the hospital setting. www.trihealth.com.
39. Protti, D., & Catz, M. (2002). The HER and resident safety: A paradigm shift for healthcare decision-makers. *ElectronicHealthcare*, 1(3), 32-41.

Appendices

Table 1 - Characteristics of Facilities

	Facilities	**Care-level**			
	N	IC only	IC & EC	Multi-level	EC only
Total	**174 [100.0]**	**104 [59.8]**	**36 [20.7]**	**16 [9.2]**	**18 [10.3]**
Beds					
<50	36 (20.7)	26 (25.0)	5 (13.9)	3 (18.8)	2 (11.1)
50-99	80 (46.0)	51 (49.0)	16 (44.4)	5 (31.3)	8 (44.4)
100-149	34 (19.5)	17 (16.3)	8 (22.2)	6 (37.5)	3 (16.7)
150 or more	24 (13.8)	10 (9.6)	7 (29.2)	2 (12.5)	5 (27.8)
Profit					
For-Profit	52 (29.9)	23 (22.1)	21 (58.3)	6 (37.5)	2 (11.1)
Non-Profit	122 (70.1)	81 (77.9)	15 (41.7)	10 (62.5)	16 (88.9)
Chain					
Part of chain	13 (7.5)	3 (2.9)	8 (22.2)	2 (12.5)	0 (0.0)
Independent	161 (92.5)	101 (97.1)	28 (77.8)	14 (87.5)	18 (100.0)
Health Authority					
Interior	42 (24.1)	29 (27.9)	5 (13.9)	2 (12.5)	6 (33.3)
Fraser	51 (29.3)	30 (28.8)	12 (33.3)	5 (31.3)	4 (22.2)
Vancouver Coastal	38 (21.8)	20 (19.2)	15 (41.7)	2 (12.5)	1 (5.6)
Vancouver Island	34 (19.5)	20 (19.2)	3 (8.3)	6 (37.5)	5 (27.8)
Northern	9 (5.2)	5 (4.8)	1 (2.8)	1 (6.3)	2 (11.1)

Note: Number in curved () parentheses represents column percentage. Number in squared [ ] parentheses] represents row percentage.

Table 2 – ANOVA Variables By Care-level

Variable	Care-level	N	Mean (STD)	Median	F-value	Bonferroni
Occupational Injury Rate (injuries per 100 person-years)						
Total Staff	IC only	95	17.79 (9.34)	16.46	3.07*	IC-multi*
	IC&EC	34	18.17 (10.45)	17.49		
	multi	16	25.52(11.11)	26.91		
	EC only	12	16.80 (8.81)	15.12		
	Total	157	18.58 (9.93)	16.85		
CA	IC only	103	20.78 (13.18)	18.05	3.28*	IC-multi*
	IC&EC	35	18.49 (10.77)	16.91		IC&EC-multi*
	multi	16	30.49 (20.11)	30.53		
	EC only	19	18.87 (11.62)	16.17		
	Total	173	21.00 (13.62)	17.61		
LPNCA	IC only	104	20.72 (13.01)	18.68	3.00*	IC-multi*
	IC&EC	35	18.68 (11.81)	16.99		IC&EC-multi*
	multi	16	30.49 (19.94)	29.80		
	EC only	19	20.19 (12.99)	16.49		
	Total	174	21.15 (13.77)	17.84		
Direct Care	IC only	97	17.01 (10.66)	15.22	2.65*	N/A
	IC&EC	34	16.07 (9.94)	15.13		
	multi	16	24.60 (13.90)	25.11		
	EC only	19	16.54 (9.42)	13.62		
	Total	166	17.50 (10.89)	15.27		
Support Staff	IC only	103	12.08 (10.46)	10.86	3.15*	IC-multi*
	IC&EC	35	15.26 (10.38)	12.96		
	multi	14	21.30 (17.67)	14.38		
	EC only	12	12.12 (10.83)	11.28		
	Total	164	13.55 (11.45)	11.40		
Other Staff	IC only	103	10.27 (18.66)	4.44	3.48*	IC-multi**
	IC&EC	36	12.59 (19.91)	5.83		
	multi	15	27.64 (30.88)	19.27		
	EC only	18	16.02 (21.34)	10.05		
	Total	172	12.87 (20.89)	6.27		
Dayshift Staff Ratio (Residents/FTE)						
Total staff	IC only	84	3.12 (0.61)	3.05	8.37**	IC -'IC&EC'*
	IC&EC	28	2.73 (0.64)	2.74		IC -'multi**
	multi	12	2.46 (0.83)	2.33		IC only-'EC only'**
	EC only	11	2.38 (0.59)	2.15		
	Total	135	2.92 (0.69)	2.94		
RN	IC only	84	27.48 (15.42)	23.51	3.20*	N/A
	IC&EC	28	21.02 (6.92)	20.75		
	multi	12	19.92 (8.79)	17.60		
	EC only	12	19.62 (5.45)	18.65		
	Total	136	24.79 (13.28)	22.73		
CA	IC only	94	9.58 (2.32)	8.81	24.77**	IC -'IC&EC'**
	IC&EC	31	7.08 (2.26)	6.34		IC -'multi**
	multi	14	6.21 (2.21)	5.74		IC only-'EC only'**
	EC only	13	5.17 (2.15)	4.41		
	Total	152	8.38 (2.77)	8.09		
LPNCA	IC only	95	9.11 (1.97)	8.81	28.55**	IC -'IC&EC'**
	IC&EC	31	6.86 (2.32)	6.34		IC -'multi**
	multi	14	5.78 (1.65)	5.74		IC only-'EC only'**
	EC only	13	4.90 (2.01)	4.41		EC only-'IC&EC'*
	Total	153	7.99 (2.51)	8.09		
Direct Care	IC only	84	6.53 (1.22)	6.48	29.88**	IC -'IC&EC'**
	IC&EC	28	4.91 (1.21)	4.85		IC -'multi**
	multi	12	4.25 (1.20)	4.07		IC only-'EC only'**
	EC only	12	4.01 (1.33)	3.72		
	Total	136	5.77 (1.57)	5.86		

* The mean difference is significant at the .05 level. ** The mean difference is significant at the .01 level

Number in parentheses represents Standard Deviation.

Table 3 – Occupational Injury Rates by Care-level

	RN	LPN	CA	LPNCA	Direct Care	Support Staff	Total Staff
All Care Levels							
Facilities	N=173	N=50	N=173	N=174	N=166	N=164	N=157
Mean	7.68	17.00	21.00	21.15	17.50	13.55	18.58
Median	**5.36**	**7.90**	**17.61**	**17.84**	**15.27**	**11.40**	**16.85**
STD	11.20	29.55	13.62	13.77	10.89	11.45	9.93
Range of lowest group	0.00-0.00	0.00-0.00	0.00-11.39	0.00-11.27	0.00-9.90	0.00-5.94	0.91-10.43
Range of highest group	10.11-91.43	31.53-193.79	28.21-85.70	29.17-85.70	23.93-57.57	17.65-57.14	25.06-50.66
IC only							
Facilities	N=103	N=29	N=103	N=104	N=97	N=103	N=95
Mean	7.04	11.49	20.78	20.72	17.01	12.08	17.79
Median	**4.62**	**5.71**	**18.05**	**18.68**	**15.22**	**10.86**	**16.46**
STD	11.12	13.91	13.18	13.01	10.66	10.46	9.34
Range of lowest group	0.00-0.00	0.00-0.00	0.00-11.43	0.00-11.76	0.00-10.09	0.00-5.34	0.91-10.38
Range of highest group	9.08-91.43	20.95-41.67	26.98-65.52	28.57-65.52	22.63-50.63	16.47-56.88	24.08-44.86
IC & EC							
Facilities	N=35	N=10	N=35	N=35	N=34	N=35	N=34
Mean	8.11	29.27	18.49	18.68	16.07	15.26	18.17
Median	**6.86**	**9.20**	**16.91**	**16.99**	**15.13**	**12.96**	**17.49**
STD	7.97	59.17	10.77	11.81	9.94	10.38	10.45
Range of lowest group	0.00-1.96	0.00-0.00	2.14-10.55	2.14-10.55	3.13-8.97	0.00-7.29	3.37-10.13
Range of highest group	12.54-31.17	26.35-193.79	24.21-54.77	21.57-54.77	18.92-47.58	20.16-44.44	23.39-50.66
Multi-level							
Facilities	N=16	N=6	N=16	N=16	N=16	N=14	N=16
Mean	9.02	28.87	30.49	30.49	24.60	21.30	25.51
Median	**7.26**	**36.15**	**30.53**	**29.80**	**25.11**	**14.38**	**26.91**
STD	10.65	17.60	20.11	19.94	13.90	17.67	11.11
Range of lowest group	0.00-0.61	0.00-11.43	0.00-15.34	1.57-15.30	3.74-12.76	0.00-6.94	5.48-13.95
Range of highest group	10.67-43.32	41.43-45.71	41.19-85.70	41.19-85.70	33.58-57.57	37.48-57.14	35.08-39.33
EC only							
Facilities	N=19	N=5	N=19	N=19	N=19	N=12	N=12
Mean	9.22	10.15	18.87	20.19	16.54	12.12	16.80
Median	**4.00**	**5.71**	**16.17**	**16.49**	**13.62**	**11.28**	**15.12**
STD	16.64	14.56	11.62	12.99	9.42	10.83	8.81
Range of lowest group	0.00-0.00	0.00-0.00	5.35-8.33	7.82-9.78	5.79-8.18	0.00-4.00	6.82-8.61
Range of highest group	6.16-66.67	22.53-35.09	24.78-46.10	27.17-53.19	24.78-34.97	15.29-37.41	24.93-33.58

* Injury rates are presented as the number of time-loss injuries per 100 person-years.
STD represents Standard Deviation.
Lowest and highest groups for CA, LPNCA, Support and Other represent quartiles.
Lowest and highest groups for RN and LPN represent three categories.

Table 4 – Range of Staff Ratio Quartiles* by Care-level

Occupational Group	Lowest Quartile of Staff Ratios*		Highest Quartile of Staff Ratios*	
	All Shifts	Day Shift	All Shifts	Day Shift
All Facilities				
RN	3.37-8.23	7.99-18.55	12.00-95.45	26.15-105.11
LPN	4.95-15.81	11.43-30.09	75.22-131.14	88.76-308.64
CA	0.96-3.17	1.95-6.62	4.49-7.42	10.01-18.68
LPNCA	0.96-3.00	1.95-6.08	4.38-7.38	9.65-14.95
Direct Care	0.85-2.28	1.69-4.66	3.05-4.83	6.91-11.17
Support Staff	3.08-5.95	3.08-6.71	7.76-15.00	9.66-22.38
Other Staff	2.17-9.14	4.15-15.83	18.43-103.92	35.50-137.78
Total Staff	**0.61-1.51**	**1.16-2.53**	**1.94-3.12**	**3.32-5.90**
IC only				
RN	6.63-9.41	13.39-19.93	12.35-95.45	27.42-105.11
LPN	4.95-17.45	11.43-35.89	77.07-131.14	84.39-147.79
CA	2.95-4.19	5.44-8.12	4.73-7.42	10.61-18.68
LPNCA	2.33-3.67	5.44-7.88	4.61-6.71	10.29-14.40
Direct Care	2.09-2.70	2.96-5.70	3.27-4.36	7.32-11.71
Support Staff	3.08-6.15	3.08-7.00	7.92-12.79	9.64-22.78
Other Staff	2.98-8.41	5.11-16.29	17.48-54.50	32.35-137.78
Total Staff	**1.20-1.72**	**1.78-2.70**	**2.00-2.80**	**3.39-5.90**
IC & EC				
RN	3.37-7.70	7.99-15.53	11.46-15.96	25.23-37.72
LPN	6.48-19.09	14.26-24.24	81.83-117.42	110.54-148.83
CA	2.08-2.89	3.12-5.71	3.60-7.38	8.27-14.95
LPNCA	1.90-2.83	2.97-5.66	3.57-7.38	8.27-14.95
Direct Care	1.43-2.12	2.34-4.40	2.58-4.83	5.70-7.03
Support Staff	4.05-5.22	4.69-6.39	7.69-12.30	10.30-12.30
Other Staff	7.06-11.63	4.50-18.70	22.28-66.67	50.89-91.35
Total Staff	**0.88-1.38**	**1.46-2.22**	**1.80-3.12**	**3.24-3.91**
Multi-level				
RN	5.68-7.84	11.66-15.04	10.02-16.46	22.85-44.64
LPN	12.86-15.56	20.02-23.67	76.97-96.00	255-49-308.64
CA	0.96-2.62	1.95-4.88	3.73-6.99	8.01-10.89
LPNCA	0.96-2.56	1.95-4.82	3.47-6.99	7.20-8.23
Direct Care	0.85-2.19	1.69-3.77	2.53-4.16	4.88-6.52
Support Staff	4.29-4.68	4.76-5.55	7.38-7.96	7.97-10.71
Other Staff	2.57-6.02	9.54-11.18	21.03-103.92	35.61-50.31
Total Staff	**0.63-1.22**	**1.16-1.90**	**1.63-2.41**	**3.04-4.00**
EC only				
RN	4.09-7.10	13.37-14.87	9.90-78.00	24.95-30.55
LPN	7.80-8.29	13.24-13.24+	69.47-119.05	39.77-39.77+
CA	1.21-2.40	2.29-3.96	3.33-4.83	6.27-10.29
LPNCA	1.21-2.29	2.29-3.96	3.01-4.41	5.66-10.29
Direct Care	0.94-1.72	2.09-3.29	2.35-3.09	4.61-7.35
Support Staff	4.24-4.99	4.85-6.32	7.76-15.00	10.21-11.58
Other Staff	2.17-7.85	4.15-10.53	15.52-21.11	34.76-40.70
Total Staff	**0.61-1.09**	**1.58-1.94**	**1.66-1.98**	**3.06-3.22**

* Staff Ratios are presented as the number of residents provided care by each Full-Time Equivalent position in that occupational group (residents/FTE).

+Only 2 facilities in EC only had LPNs on dayshift.

Table 5A – Correlations (Spearman r) between staff ratio and injury rates

Staff Ratio (FTEs/100 residents)	Injury Rate							
	Total Staff	**RN**	**LPN**	**Care Aide**	**LPNCA**	**Direct Care**	**Support Staff**	**Other Staff**
Staffing correlations with injury rate within same occupation								
All Care-levels Staff Ratio								
All-Shifts	.036 (157)	-.028 (166)	-.094 (50)	.027 (173)	-.019 (174)	-.058 (166)	-.007 (159)	**.162* (169)**
Dayshift	.015 (133)	-.062 (136)	.035 (40)	-.031 (152)	-.058 (153)	-.141 (136)	-.109 (146)	-.024 (141)
IC only Staff Ratio								
All-Shifts	.153 (95)	-.059 (97)	-.238 (29)	.107 (103)	.040 (104)	.007 (97)	-.016 (100)	.090 (100)
Dayshift	.069 (83)	-.109 (84)	-.189 (26)	-.090 (94)	-.120 (95)	-.190 (84)	-.152 (94)	.062 (90)
IC only Staffing correlations with injury rate in another occupation								
Other Staff all-shifts	.103 (92)	-.112 (99)	.101 (28)	.102 (99)	.087 (100)	.075 (93)	**.213* (99)**	.090 (100)
RN dayshift	-.131 (83)	-.109 (84)	.108 (25)	-.198 (83)	**-.223* (84)**	-.174 (84)	.103 (83)	-.018 (83)
CA dayshift	-.137 (86)	-.167 (93)	.051 (27)	-.090 (94)	-.089 (94)	-.126 (87)	-.017 (93)	**-.223* (93)**
Direct Care dayshift	-.165 (83)	**-.225* (84)**	.118 (25)	**-.218* (83)**	-.170 (84)	-.190 (84)	-.044 (83)	-.146 (83)
Support Staff dayshift	.113 (87)	-.042 (94)	.100 (28)	.189 (94)	**.215* (95)**	.190 (88)	-.152 (94)	**-.277** (94)**

Number in parentheses represents the number of facilities.

* Correlation is significant at the 0.05 level (2-tailed).

Table 5B – Correlations (Spearman r) between staff ratio and injury rate quartiles

Staff Ratio (Residents/FTE	Injury Rate									
	Total Staff		LPNCA		CA		Direct Care		RN	LPN
	Q1	Q4	Q1	Q4	Q1	Q4	Q1	Q4	Q4	Q4
All Care-levels										
RN all-shifts	.120 (38)	.008 (43)	-.303 (41)	.040 (42)	**-.311* (41)**	.043 (49)	-.223 (41)	.094 (41)	.165 (58)	-.134 (17)
LPN all-shifts	.700 (5)	-.025 (15)	-.152 (10)	.026 (16)	-.143 (8)	**.526* (20)**	.036 (7)	-.161 (15)	-.307 (22)	.164 (17)
CA all-shifts	-.084 (38)	-.162 (42)	-.300 (43)	.009 (42)	-.204 (44)	-.035 (50)	**-.339* (41)**	.122 (40)	.062 (57)	-.315 (16)
LPNCA all-shifts	-.105 (38)	-.169 (43)	-.287 (43)	.067 (43)	-.198 (44)	.068 (50)	**-.319* (41)**	.107 (41)	-.040 (58)	-.336 (17)
Direct Care all-shifts	-.070 (38)	-.123 (43)	**-.377* (41)**	.082 (42)	**-.343* (41)**	.092 (49)	**-.375* (41)**	.129 (41)	.051 (58)	-.270 (17)
LPN dayshift	**.900* (5)**	.036 (11)	-.286 (7)	-.136 (11)	-.771 (6)	.424 (14)	-.486 (6)	-.212 (10)	-.218 (15)	.399 (13)
Direct Care dayshift	-.141 (32)	**-.340* (37)**	-.312 (32)	-.148 (34)	-.206 (33)	-.091 (40)	-.331 (33)	-.114 (33)	.023 (49)	-.409 (14)
IC only										
RN all-shifts	-.162 (24)	**.463* (24)**	**-.553** (23)**	.274 (25)	-.497* (22)	.168 (25)	-.343 (22)	.394 (24)	.327 (35)	**-.895** (9)**
LPN all-shifts	-.500 (3)	-.050 (8)	-.200 (4)	.209 (11)	-.400 (4)	.582 (11)	**-1.000** (3)**	.355 (11)	-.073 (11)	.146 (10)
Direct Care all-shifts	-.335 (24)	.003 (24)	-.316 (23)	.137 (25)	-.351 (22)	.203 (25)	-.342 (22)	-.022 (24)	.129 (35)	**-.795* (9)**
Support all-shifts	.117 (24)	-.096 (23)	.390 (24)	-.119 (25)	.372 (24)	-.142 (25)	.319 (21)	.246 (23)	-.144 (33)	**-.632* (10)**
RN dayshift	-.171 (21)	-.100 (24)	**-.453* (21)**	-.040 (22)	-.410 (20)	-.016 (22)	-.309 (20)	.047 (23)	.130 (32)	**-.881** (8)**
LPN dayshift	-.500 (3)	.050 (8)	-.500 (3)	-.136 (11)	**-1.000** (3)**	.176 (10)	**-1.000** (3)**	-.115 (10)	-.267 (8)	.134 (10)
Direct Care dayshift	-.429 (21)	-.303 (24)	-.307 (21)	-.213 (22)	-.414 (20)	-.023 (22)	**-.463* (20)**	-.168 (23)	.009 (32)	**-.762* (8)**

** Correlation is significant at the 0.01 level (2-tailed).

- Correlation is significant at the 0.05 level (2-tailed).
- Q1= lowest injury rate quartile. Q4= highest injury rate quartile.

Number in parentheses represents the number of facilities.

Table 6 – Odds Ratio of Injury Rate Category In Relation To Continuous Staff Ratio

Injury Rate Category as outcome	Staff Ratio	Odds ratio	% Change of probability with unit increase in staff ratio	95% CI	p-value for trend
Injury Rate 'above median' [1]					
(X) RN injury rate	Direct Care dayshift [b]	0.59*	Decrease by 41%	0.35-0.97	.037
	Direct Care all-shifts [b]	0.60*	Decrease by 40%	0.36-0.999	.049
(X) LPN injury rate	LPN all-shifts [b]	0.42*	Decrease by 58%	0.18-0.95	.038
	Support staff all-shifts [b]	2.57*	Increase by 157%	1.05-6.29	.039
Total injury rate [a, b]			**n.s.**		
CA injury rate [a, b]			**n.s.**		
LPNCA injury rate [a, b]			**n.s.**		
Direct Care injury rate [a, b]			**n.s.**		
			n.s.		
Injury Rate 'in highest quartile' [1]					
Total injury rate [a, b]			**n.s.**		
CA injury rate [a, b]			**n.s.**		
LPNCA injury rate [a, b]			**n.s.**		
Direct Care injury rate [a, b]			**n.s.**		
Injury Rate 'in highest group" [1]					
(X) LPN injury rate	Other staff dayshift [a]	2.61*	Increase by 161%	1.21-5.65	.015
	Total staff all-shifts [b]	4.36*	Increase by 336%	1.16-16.36	.029
(X) RN injury rate [a, b]			**n.s.**		
Injury Rate 'in lowest quartile' [1]					
Total injury rate	RN dayshift [a]	1.03*	Increase by 3%	1.001-1.06	.045
	Direct Care dayshift [a]	1.35*	Increase by 35%	1.02-1.77	.034
CA injury rate [a, b]			**n.s.**		
LPNCA injury rate [a, b]			**n.s.**		
Direct Care injury rate [a, b]			**n.s.**		
Injury Rate 'in lowest group' [1]					
(X) RN injury rate	Direct Care dayshift [b]	1.82*	Increase by 82%	1.01-3.26	.046
(X) LPN injury rate	LPN all-shifts [a]	1.85*	Increase by 85%	1.06-3.23	.032
	LPN all-shifts [b]	2.39*	Increase by 139%	1.05-5.43	.038
	Support staff all-shifts [b]	0.39*	Decrease by 61%	0.16-0.96	.039

Note: The RN and LPN injury rates where divided into groups rather than quartiles due to the skewed distribution towards zero injuries. The lowest injury-rate group includes all the facilities with no injuries. The highest injury-rate group includes the top third of injury rates.
'Staff Ratio' values are Residents/FTE. **1** See cut-off values in Table 3
***** p-value is significant at the .05 level. **n.s.** not statistically significant association
[a] represents values for entire sample. **[b]** represents values for 'IC only'
(X) represents binary logistic regression using staff ratio as a ranked continuous variable.

Table 7 – Odds Ratio of Injury Rate Category In Relation To Continuous Staff Ratio

Injury Rate	Staff Ratio	1st Quartile	2nd Quartile		3rd Quartile		4th Quartile	
		Odds ratio	OR	95% CI	OR	95% CI	OR	95% CI
Injury Rate 'above median'[1]								
Total Injury Rate	Support staff all-shifts [b]	1.0	1.13	0.35-3.65	3.43*	1.04-11.33	1.50	0.48-4.65
	Support staff dayshift [b]	1.0	7.20**	1.88-27.59	8.23**	2.18-31.13	2.95	0.78-11.09
	Other staff all-shifts [b]	1.0	3.75*	1.12-12.54	2.00	0.61-6.58	2.60	0.80-8.49
RN	LPNCA all-shifts [b]	1.0	0.20**	0.06-0.64	0.61	0.19-1.89	0.35	0.11-1.10
CA	Total staff all-shifts [a]	1.0	1.51	0.62-3.70	2.67*	1.07-6.64	1.44	0.58-3.54
	Other staff all-shifts [a]	1.0	3.28*	1.34-8.06	1.10	0.46-2.63	1.47	0.62-3.49
	Other staff all-shifts [b]	1.0	6.38**	1.83-32.23	1.67	0.53-5.29	2.30	0.73-7.27
	Support staff dayshift [b]	1.0	4.55*	1.33-15.57	3.09	0.95-10.08	4.25*	1.23-14.64
LPNCA	Support staff dayshift [b]	1.0	5.63**	1.59-19.85	3.82*	1.13-12.87	5.63**	1.59-19.85
	Other staff all-shifts [a]	1.0	3.08*	1.27-7.51	1.10	0.47-2.61	1.00	0.42-2.37
	Other staff all-shifts [b]	1.0	6.73**	1.94-23.36	1.67	0.53-5.29	1.96	0.62-6.19
Direct Care	Support staff dayshift [b]	1.0	5.67**	1.55-20.79	4.41*	1.27-15.41	5.67**	1.55-20.79
	Other staff all-shifts [a]	1.0	2.85*	1.16-7.01	0.80	0.34-1.95	1.21	0.50-2.93
	Other staff all-shifts [b]	1.0	6.00**	1.71-21.04	1.39	0.42-4.60	2.18	0.67-7.09
Injury Rate 'in highest quartile' [1]								
Total injury rate	RN all-shifts [b]	1.0	5.91*	1.12-31.20	5.25	0.98-28.18	2.92	0.50-16.69
	Other staff all-shifts [b]	1.0	8.46*	1.60-44.76	3.24	0.56-18.76	4.81	0.88-26.30
CA	RN all-shifts [b]	1.0	4.20	.97-18.18	5.00*	1.17-21.46	1.00	0.18-5.53
	CA all-shifts [b]	1.0	0.19*	0.04-0.99	1.19	0.37-3.80	0.88	0.26-2.92
	Support staff dayshift [b]	1.0	3.06	0.68-13.74	4.67*	1.09-19.90	2.63	0.57-12.13
	Other staff all-shifts [b]	1.0	5.24*	1.22-22.42	2.85	0.64-12.64	2.32	0.51-10.54
LPNCA	Support staff dayshift [b]	1.0	2.47	0.54-11.37	4.67*	1.09-19.90	3.06	0.68-13.74
	Other staff all-shifts [b]	1.0	4.89*	1.15-20.79	2.32	0.51-10.54	2.85	0.64-12.64
Direct Care	RN all-shifts [b]	1.0	7.33*	1.40-38.34	6.60*	1.25-34.94	1.57	0.24-10.37
	Other staff all-shifts [b]	1.0	9.31**	1.78-48.72	4.13	0.74-23.15	3.06	0.53-17.66
Injury Rate 'in highest group' [1]								
(X) RN injury rate	LPN all-shifts [a]	1.0	0.15*	0.02-0.87	0.31	0.06-1.61	0.50	0.10-2.68
	CA dayshift [b]	1.0	0.08*	0.16-0.44	0.80	0.22-2.95	0.44	0.14-1.32
	LPNCA all-shifts [b]	1.0	0.18*	0.05-0.68	0.63	0.21-1.88	0.47	0.15-1.47
	LPNCA dayshift [b]	1.0	0.24*	0.06-0.90	0.91	0.29-2.87	0.52	0.10-2.68
(X) LPN	Other staff dayshift [a]	1.0	1.13	0.15-8.21	3.86	0.59-25.29	18.00*	1.24-260.92

Note: The RN and LPN injury rates where divided into groups rather than quartiles due to the skewed distribution towards zero injuries. The lowest injury-rate group includes all the facilities with no injuries. The highest injury-rate group includes the top third of injury rates.

The p-values represent the changes in the probability of hazard for the independent variable as an ordered variable from the lowest to the highest quartile.

***** p-value is significant at the .05 level. ****** p-value is significant at the .01 level.

[a] represents values for entire sample. **[b]** represents values for 'IC only'. 'Staffing Ratio' values are Residents/FTE

1 See cut-off values in Table 3

(X) represents binary logistic regression using staff ratio as a ranked continuous variable.

Table 7 –Categorical Independent Variables in Relation to Injury Rates as Dependent Variable (continued)

Injury Rate	Staff Ratio	1st Quartile	2nd Quartile		3rd Quartile		4th Quartile	
		Odds ratio	OR	95% CI	OR	95% CI	OR	95% CI
Injury Rate 'in lowest quartile' [1]								
Total Injury Rate								
	Total staff all-shifts [b]	1.0	1.20	0.37-3.92	0.09*	0.01-0.77	0.71	0.20-2.49
	LPNCA all-shifts [a]	1.0	2.07	0.63-6.73	3.58*	1.14-11.29	1.86	0.56-6.17
	Support staff all-shifts [b]	1.0	0.35	0.09-1.36	0.07*	0.01-0.59	0.90	0.29-2.84
CA								
	Total staff all-shifts [b]	1.0	0.33	0.09-1.29	0.16*	0.03-0.84	0.73	0.22-2.45
	Support staff all-shifts [b]	1.0	0.56	0.16-1.92	0.16*	0.03-0.85	0.69	0.21-2.29
	Support staff dayshift [b]	1.0	.15*	0.04-0.64	0.14**	0.03-0.58	0.29	0.08-1.06
	Other staff all-shifts [a]	1.0	.20**	0.07-0.61	0.40	0.15-1.05	0.59	0.24-1.46
LPNCA								
	Total staff all-shifts [b]	1.0	0.44	0.12-1.59	0.15*	0.03-0.80	0.73	0.22-2.45
	Support staff all-shifts [b]	1.0	0.56	0.16-1.92	0.16*	0.03-0.81	0.69	0.21-2.29
	Support staff dayshift [b]	1.0	.015*	0.04-0.64	0.19*	0.05-0.22	0.21*	0.06-0.81
	Other staff all-shifts [a]	1.0	0.29*	0.10-0.65	0.49	0.19-1.30	0.72	0.29-1.81
Direct Care								
	Total staff all-shifts [b]	1.0	0.67	0.19-2.34	0.18*	0.03-097	0.71	0.20-2.49
	Support staff all-shifts [b]	1.0	0.42	0.11-1.63	0.08*	0.01-0.70	0.73	0.22-2.43
	Support staff dayshift [b]	1.0	0.16*	0.03-0.88	0.43	0.12-1.58	0.37	0.09-1.45
	Other staff all-shifts [a]	1.0	0.23*	0.08-0.72	0.68	0.27-1.75	0.52	0.20-1.38
Injury Rate 'in lowest group' [1]								
(X) RN Injury Rate								
	LPNCA all-shifts [b]	1.0	3.70*	1.16-11.86	1.0	0.29-3.41	2.13	0.66-6.89
	Direct Care dayshift [b]	1.0	1.0	0.21-4.67	1.70	0.40-7.20	4.68*	1.17-18.69
(X) LPN [a,b]					**n.s.**			

Note: The RN and LPN injury rates where divided into groups rather than quartiles due to the skewed distribution towards zero injuries. The lowest injury-rate group includes all the facilities with no injuries. The highest injury-rate group includes the top third of injury rates.

The p-values represent the changes in the probability of hazard for the independent variable as an ordered variable from the lowest to the highest quartile.

***** p-value is significant at the .05 level. ****** p-value is significant at the .01 level.

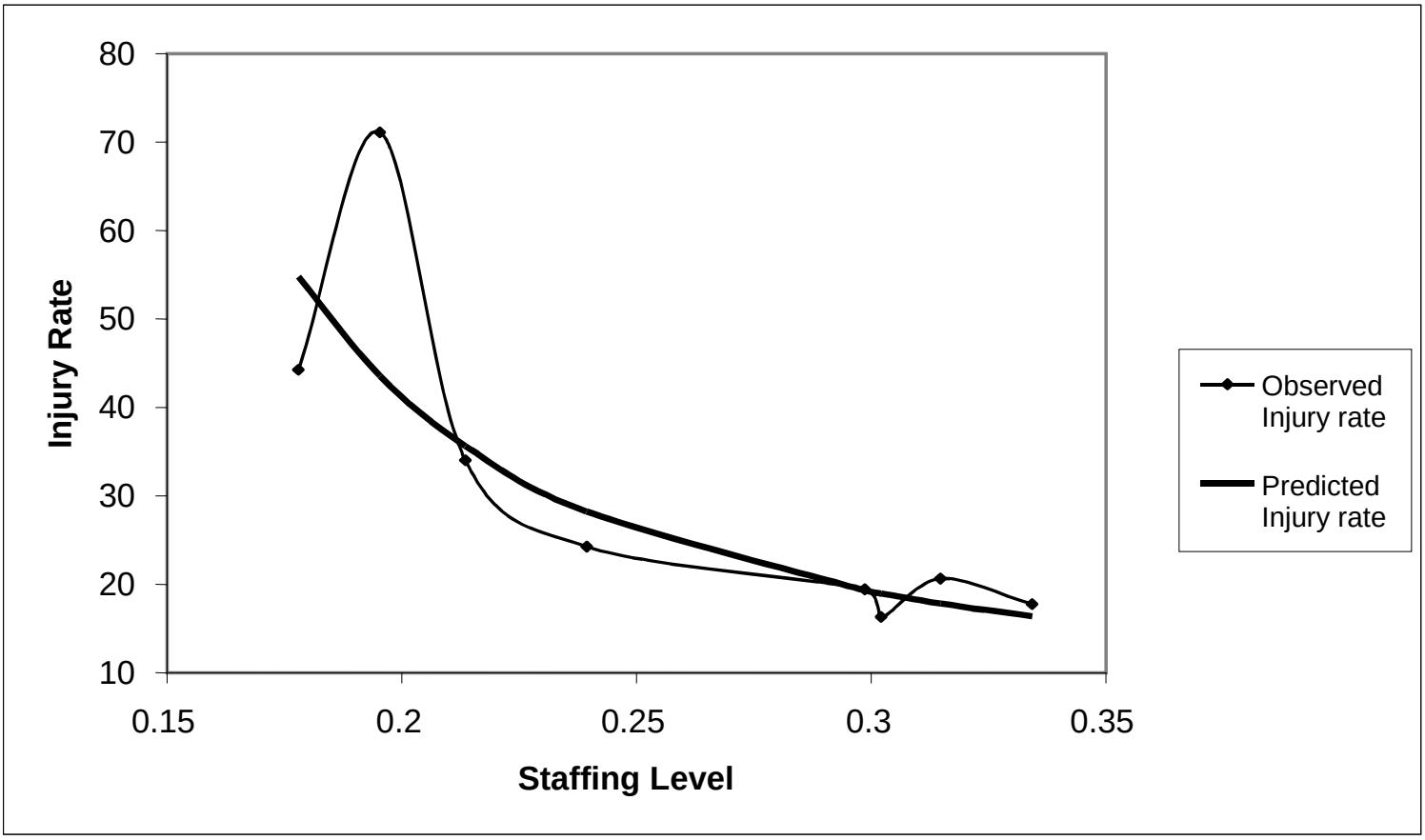
n.s. represents 'not statistically significant association'

[a] represents values for entire sample. **[b]** represents values for 'IC only'. 'Staffing Ratio' values are Residents/FTE

1 See cut-off values in Table 3

(X) represents binary logistic regression using staff ratio as a ranked continuous variable.

Figure 1: Relationship between staffing and injury rate (1Jan99 30Jun01).



Source: Cohen et al. 2003.

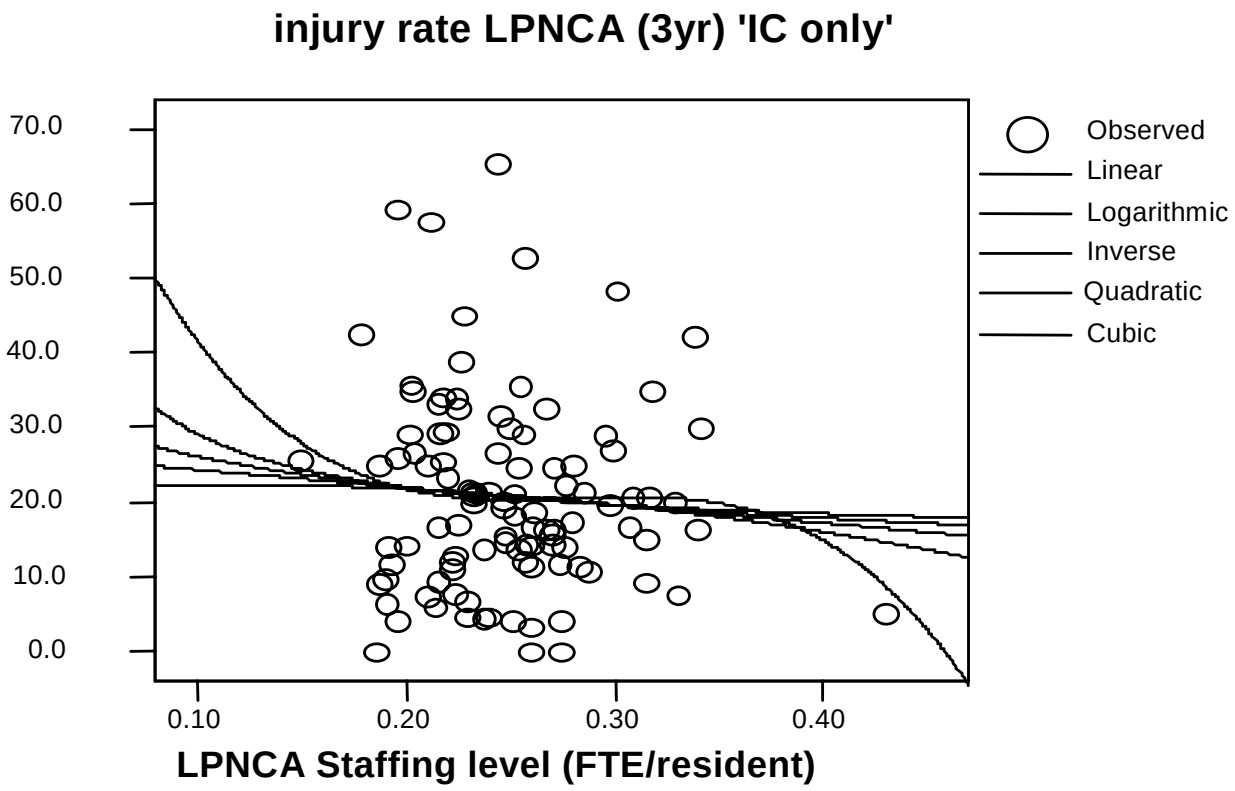


Figure 2 – Relationship between staffing level and injury rates for LPN/CAs in 'IC only' facilities (1Jan 1999-31Dec2001)

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