Effects of New Zealand's Health Reengineering on Nursing and Patient Outcomes

Barbara A. McCloskey, RN, DNSc, and Donna K. Diers, RN, PhD, FAAN†*

Background: In 1993, New Zealand (NZ) implemented policies aimed at controlling costs in the country's public health care system through market competition, generic management, and managerialism. The cost control focus was similar to reengineering efforts implemented by other countries struggling with escalating health care costs, particularly the United States.

Objective: The study's purpose was to examine the effects hospital reengineering may have on adverse patient outcomes and the nursing workforce.

Research Design: The study was a retrospective, longitudinal analysis of administrative data. Relationships between adverse outcome rates and nursing workforce characteristics were examined using autoregression analysis.

Subjects: All medical and surgical discharges from NZ's public hospitals (n = 3.3 million inpatient discharges) from 1989 through 2000 and survey data from the corresponding nursing workforce (n = 65,221 nurse responses) from 1993 through 2000 were examined.

Measures: Measures included the frequency of 11 nurse sensitive patient outcomes, average length of stay, and mortality along with the number of nursing full time equivalents (FTEs), hours worked, and skill mix.

Results: After 1993, nursing FTEs and hours decreased 36% and skill mix increased 18%. Average length of stay decreased approximately 20%. Adverse clinical outcome rates increased substantially. Mortality decreased among medical patients and remained stable among surgical patients. The relationship between changes in nursing and adverse outcomes rates over time were consistently statistically significant.

Conclusions: In the chaotic environment created in NZ by reengineering policy, patient care quality declined as nursing FTEs and hours decreased. The study provides insight into the role organizational change plays in patient outcomes, the unintended consequences of health care reengineering and market approaches in health care, and nursing's unique contribution to quality of care.

Key Words: market competition, cost containment, patient outcomes, quality of care, nursing

(*Med Care* 2005;43: 1140–1146)

From the *Bridgeport Hospital, Bridgeport, Connecticut; †Yale University School of Nursing, New Haven, Connecticut.

Supported by the Delta Mu chapter of Sigma Theta Tau International.

Reprints: Barbara McCloskey, 10 New Lebbon Road, Sandy Hook, CT 06482. E-mail: mcclosba@yahoo.com.

ISSN: 0025-7079/05/4311-1140

In 1993, the government of New Zealand (NZ) implemented policies aimed at making its public health care system more efficient, cost effective, and consumer-oriented. These policies followed nearly a decade of reengineering the nation's other state-owned enterprises to control a long-standing national budget deficit. NZ health care reform was similar to the hospital "reengineering" that occurred in the United States (U.S.) during the 1990s.[1,2] Because nursing represents a large portion of operating costs, reengineering efforts often are associated with reducing the number of nurses and collapsing nursing management structures.[3–8] Both U.S. and NZ reengineering efforts have been criticized for jeopardizing quality of patient care. Several U.S. studies found a relationship between nursing staffing and patient outcomes, providing evidence on how care quality may be affected by decreases in hospital nurse staffing.[7–13]

The purpose of this study was to examine the relationship between NZ hospital reengineering and adverse patient outcome rates. Although it is widely recognized that a great deal of change in nurse staffing has occurred within the context of hospital reengineering, few well-designed studies have assessed the impact of reengineering on quality of care.[1,2,8,9] The availability of comprehensive longitudinal administrative data on NZ nurses and hospital discharges offered a unique opportunity. This study is the first to examine the effect hospital reengineering may have had on the quality of care and nursing workforce in NZ hospitals, the relationship between nursing and outcomes in the context of hospital reengineering, and the effect of reengineering on quality of care in hospitals in a country other than the United States.

Reengineering in New Zealand

NZ comprises 2 principal and several smaller islands in the South Pacific. In 2001, the country's population (n = 3,875,000) was comparable with Connecticut; its land mass is approximately the size of Colorado. NZ began forming its public health system in 1938 and was the first country to introduce a fully public-funded health care system.[14] In 2002, NZ had 85 public hospitals, 12,484 public hospital beds and, in 2001, 563,894 inpatient discharges.[15]

NZ's health care reengineering strategies included the attempted creation of a health care market, replacement of traditional leadership with professional "business" managers, and managerialism.[14] The health care market was supposed to emerge once the government's dual roles as the country's primary health care *provider* and *purchaser* were separated.

The government's health care provider role was divided among 23 hospital-centered regionally distributed health care delivery systems called Crown Health Enterprises (CHE), and the purchaser role was divided among 4 geographic areas and called Regional Health Authorities (RHA). The government expected new non- and for-profit entities would enter the market and compete with CHEs and other existing community-based providers for RHA-funded service contracts. The theory was that cost efficiency would result as higher quality, cost effective providers emerged and drove poor performing, higher cost providers out of the market.

NZ reengineering embraced generic management, which is based on the belief that a manager in 1 industry can successfully apply that leadership experience to another industry. Generic managers were installed in several layers of hospital management. Traditional hospital administrators were replaced with chief executives officers (CEOs) charged to run hospitals like for-profit businesses. Boards of directors from the private sector were appointed to support CEOs in achieving a for-profit mission. Nurses in management positions were replaced with non-nurse business managers.

Managerialism is concerned with rational analysis of organizational inputs and outputs, routine efficiency, direct line management, and close supervision of personnel.[16] Thus, the new hospital management structures in NZ were held accountable for meeting organizational efficiency and financial performance targets. However, accountability for clinical outcomes was not a priority specified under the new structures, and few quality monitoring practices were in place in NZ hospitals before, during, or in the immediate aftermath of reengineering.[17] The new structures were put into place with little public consultation or debate among health professionals.[18]

Nursing was impacted substantially. In the years just before health care reengineering, legislation eliminated the nursing department within the Ministry of Health and left 1 nurse to represent the profession in the government.[19] Other legislative initiatives had weakened all of the nations' labor unions' collective bargaining power, including the nursing labor union.[20] Consistent with the U.S. experience, NZ reengineering reduced hospital nursing staffs and dismantled nursing leadership structures in hospitals (personal communication with Frances Hughes, RN, MA, DN, NZ Ministry of Health Chief Nursing Advisor, April 2003). Control over nursing budgets was handed over to non-nursing managers, clinical areas lacked supplies and equipment, and many senior nurses were replaced by new graduates, leaving few mentors and clinical experts on hospital nursing units.[21]

By 1996, government leaders acknowledged that reengineering and the for-profit mission were causing upheaval throughout the system and not resulting in expected cost savings. Health care costs increased by 40%, more than $57 million was spent on external consultants, and waiting lists for surgeries and procedures grew.[22] The health care market never fully developed, and government leaders eventually acknowledged it was difficult to build a market when the government owned and operated most health services and NZ was not large enough to allow health care providers to freely enter and exit the market. Citing the impossibility of meeting ambitious and essentially unattainable financial targets, many new business managers quit their upper management positions in health care within 3 years of reengineering's inception.[18]

Although the for-profit mission was abandoned in 1996, business managers still occupy many layers of hospital management and some elements of market competition among providers remain. Nursing, however, has not fully recaptured the management positions and budget control in hospitals that it had before reengineering.[21]

METHODS

The study was a retrospective analysis of longitudinal administrative data using a time series design to examine the effects of NZ reengineering policies on adverse patient outcomes and the nursing workforce. The time series includes the start of health care reform at the beginning of NZ's 1993 fiscal year through 2000. NZ's fiscal year runs from July 1 to June 30 and, in this article, years referenced are fiscal years. The Yale University School of Nursing Human Subjects Research Review Committee approved the study.

Data

Two publicly available administrative databases maintained by the NZ Health Information Service (NZHIS), the National Minimum Dataset (NMDS) and the Nursing Workforce Dataset (NWD) were used. The NMDS is a database of patient-level discharge abstracts dating from 1988 and the NWD provides demographic data on the nursing workforce. Public hospitals send electronic batches of their discharge abstracts directly to NZHIS; nursing data for the NWD are collected by a questionnaire attached to annual certification renewal forms. Completion of the nursing workforce questionnaire is mandatory and response rates typically exceed 90%. Nursing workforce data were available in hard-copy, aggregated reports from 1977 through 1994 and since 1995, individual records for each nurse responding to the questionnaire are stored in an online database.

Nursing Workforce Analysis

Registered nurses (RNs) and enrolled nurses (ENs) provide bedside nursing care in NZ's public hospitals. Hospitals do not employ unlicensed assistive personnel (UAPs) in direct patient care. Since 1990, RN education in NZ is available exclusively through 3-year university-based bachelor's programs. ENs are similar to U.S.-licensed practical/vocational nurses (LPN/LVNs). In the late 1980s, NZ decided to phase out ENs altogether by discontinuing education programs and decreasing their employment opportunities, a decision unrelated to reengineering.

The nurse sample was all medical and surgical RNs and ENs providing direct care in public hospitals from 1993 through 2000. Sample nurses in years prior to 1993 could not be identified with confidence. Medical and surgical nurses were included because the patient outcomes analyzed are specific to medical and surgical patients. Although direct care nurses could be identified, the NWD does not distinguish between inpatient and outpatient nurses. A total of 65,221 RN and EN records met the inclusion criteria. Approximately

85% were RNs and the remaining 15% were ENs (Table 1). Three workforce characteristics were examined for years 1993 through 2000: number of nursing full time equivalents (FTEs), number of nursing hours worked, and skill mix. An FTE was defined as 33 or more worked hours per week. The online data available from 1995 through 2000 allowed easy identification of sample nurses and their corresponding hours worked. For 1993 and 1994, medical and surgical nurses were identifiable in the hard copy reports but hours worked for the group were reported in aggregate by 5 "hours worked per week" categories: 1–8, 9–16, 17–24, 25–32, and 33–40. Hours worked by sample nurses for 1993 and 1994 were estimated using the percent of sample nurses in each hours category multiplied by the end point value of the hours worked category. The hours totals for each category were summed to arrive at weekly hours worked. Weekly hours worked were multiplied by 52 weeks in a calendar year to arrive at annual hours worked. Skill mix was defined as the percentage of total nursing FTEs who were RNs.

Outcomes Analysis

All adult (18-year-old or older) inpatient medical and surgical discharges from NZ's public hospitals were examined from fiscal years 1989 through 2000. Adverse outcome rates for the time period 1989 to 1993 provided baseline rates for later comparisons. Of the nearly 7.6 million public hospital discharges, there were 3,290,191 qualifying records representing 21,719,399 patient days (Table 1).

Nurse sensitive outcomes capture nursing's contribution to the quality of care and how the work of nurses influences patient outcomes.[7,11,23] The frequency of 11 nurse sensitive clinical outcomes was examined: CNS complications; decubitus ulcers; deep vein thromboses (DVTs) and pulmonary emboli (PE); pneumonia; sepsis; shock and cardiac arrest; upper gastrointestinal (UGI) bleeding; urinary tract infection (UTI); pulmonary failure; physiologic and metabolic derangement; and surgical wound infections. The remaining 2 outcomes were average length of stay (ALOS) and mortality. Frequencies of pulmonary failure, physiologic and metabolic derangement, and surgical wound infections were evaluated in the surgical group only.

Algorithms developed by Needleman et al[11] were used to identify nurse-sensitive outcomes. The algorithms use the International Classification of Diseases (ICD), Diagnosis-Related Groups (DRGs), and Major Diagnostic Categories (MDC) coding of each hospital discharge record along with some length of stay triggers and other coding combinations to identify records with adverse outcomes. ICD codes are used to classify diagnoses and operative or invasive procedures and are grouped to create DRGs, which in turn are grouped to create MDCs. Code mapping was necessary to convert the outcome rules developed using US codes to the Australian ICD, DRG, and MDC codes used in NZ. The SAS Statistical Analysis System, Version 8.0 (SAS Institute, Cary, NC), was used to construct the algorithm logic that identified patient discharge records with adverse outcomes in the NMDS.

The Needleman et al[11] method to identify discharges with adverse outcomes relies heavily on the ICD coding of the principal and secondary diagnoses. Examination of the longitudinal database revealed an increasing number of secondary diagnoses saved with each discharge record after 1993, theoretically increasing the likelihood of identifying discharges with adverse outcomes. Each discharge from 1989 through 2000 included at least 3 secondary diagnoses. To decrease the possibility that increasing adverse outcomes rates were influenced by increasing numbers of secondary diagnoses, a discharge was counted as having an adverse outcome only if the adverse outcome-qualifying ICD code appeared in the first 3 secondary diagnosis spaces of the discharge record. For most outcome rates, this resulted in 20% to 50% of adverse outcome-qualifying records being discarded each study year but decreased the likelihood that rates were inflated by the increasing numbers of secondary diagnoses.

Risk Adjustment

Each algorithm specifies the inclusion and exclusion criteria specific for that adverse outcome to identify only those patients who experienced a *preventable* adverse outcome. The inclusion and exclusion criteria create a cohort of included discharges. Thus, no further post hoc risk adjust-

TABLE 1. Medical/Surgical Nurses 1993–2000 and Medical/Surgical Discharges 1989–2000

Year	Registered Nurses	Enrolled Nurses	Total Nurses	No. Discharges	No. Patient Days	ALOS
1989/1990	n/a	n/a	n/a	239,878	1,880,456	7.8
1990/1991	n/a	n/a	n/a	245,287	1,895,878	7.7
1991/1992	n/a	n/a	n/a	240,019	1,790,639	7.5
1992/1993	n/a	n/a	n/a	245,098	1,776,861	7.2
1993/1994	7311	2186	9497	262,460	1,846,337	7.0
1994/1995	7468	1960	9428	269,803	1,870,718	6.9
1995/1996	7812	1724	9536	283,952	1,861,099	6.6
1996/1997	7529	1466	8995	285,029	1,793,926	6.3
1997/1998	6510	827	7337	291,588	1,756,490	6.0
1998/1999	6568	739	7307	297,490	1,703,505	5.7
1999/2000	6047	520	6567	308,998	1,751,590	5.7
2000/2001	6043	511	6554	320,589	1,791,900	5.6
Total	55,288	9933	65,221	3,290,191	21,719,399	6.6

ment was performed. Outcomes were examined and reported separately for medical discharges and surgical discharges.

Statistical Analysis

Three separate groups of analyses were conducted. The first examined reengineering's influence on the nursing workforce to determine whether statistically significant changes occurred in workforce variables from 1993 through 2000. The second group examined reengineering's influence on adverse outcomes to determine whether statistically significant changes occurred in adverse outcome rates from 1989 through 2000. The third examined reengineering's influence on outcomes and nursing to determine whether changes in outcome rates were statistically related to changes in the workforce variables from 1993 through 2000. Nursing variable rates are reported "per 1000 medical/surgical discharges" and outcome rates "per 1000 medical" and "per 1000 surgical" discharges. The R^2 value and the P value associated with the F-statistic are reported for each autoregression model.

Autoregression was chosen to determine statistical relationships because it is designed to account for serial autocorrelation of errors in a time series. A first order autoregression model was fit to the 3 time series. The first order autoregression model determines whether the best predictor of the dependent variable [the time series (y_t)] is the previous value in the series [independent variable (y_{t-1})]. The model for the analyses for nursing workforce characteristics and outcomes was $y_t = a + by_{t-1}$. The model for the third analysis was similar ($x_t = a + by_{t-1}$) but it determined whether the time series for an outcome rate (dependent variable) could be predicted with the time series for a nursing workforce characteristic (independent variable).

RESULTS

Reengineering's Influence on Nursing

From 1993 through 2000, combined RN and EN FTEs decreased 36% ($R^2 = 0.93$, $P < 0.0001$), as did hours worked ($R^2 = 0.95$, $P < 0.0001$), per 1000 medical/surgical discharges (Table 2 and Fig. 1). FTEs and hours worked per 1000 medical/surgical *patient days* decreased by approximately 9%. By FY 2000, there was an 18% increase in skill mix ($R^2 = 0.96$, $P = <0.0001$), with RN labor representing 93% of nursing FTEs and hours worked by medical and surgical nurses. The large increase in skill mix was more than likely influenced by the nursing profession's decision to phase out the EN role in hospitals rather than a conscious effort to employ a higher mix of RNs. The number of ENs decreased nearly 80% per 1000 discharges and 70% per 1000 patient days. The number of RNs decreased nearly 25% per 1000 discharges and although the number of RNs per 1000 patient days *increased* 8%, the increase was probably insufficient in compensating for the increased nursing workload brought on by a 70% decrease in the number of ENs.

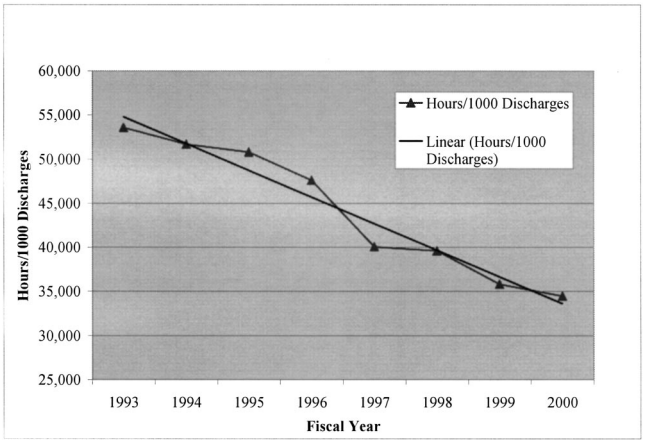

FIGURE 1. Total nurse hours per 1000 discharges, 1993 to 2000.

Reengineering's Influence on Outcomes

Table 3 and Figure 2 show the magnitude and statistical significance of changes in outcome rates from 1992 (the baseline year just before reengineering's implementation) to 1996 (the year when reengineering policies were relaxed) and from 1992 to 2000 (the time span from baseline to the last year analyzed). ALOS progressively decreased during the study years, declining 25% in medical and 18% in surgical patients. This is consistent with the experience in other countries that implemented similar DRG-based budget setting or prospective payment systems at approximately the same time.

There were statistically significant increases in the rates for CNS complications, decubitus ulcers, sepsis, UTIs, physiological and metabolic derangement, pulmonary failure, and wound infections after reengineering's 1993 implementation. The rates for DVT/PEs, UGI bleeds, pneumonia, and shock either remained stable or initially increased but later returned to rates near or below prereengineering levels. Mortality for medical discharges decreased 37% from the baseline 1992 rate to 2000 while surgical mortality remained stable.

TABLE 2. Summary of Nursing Workforce Analysis, 1993 Through 2000

Nurse Group	FTEs/1000 Discharges	Hours/1000 Discharges	Skill Mix	FTEs/1000 Patient Days	Hours/1000 Patient Days
RNs	↓ 24%	↓ 24%	↑ 18% ($R^{2\dagger} = 0.96$*)	↑ 8%	↑ 7%
ENs	↓ 78%	↓ 79%	—	↓ 70%	↓ 70%
Total Nurses	↓ 36% ($R^{2\dagger} = 0.93$*)	↓ 36% ($R^{2\dagger} = 0.95$*)	—	↓ 9%	↓ 9%

*$P < 0.0001$.
†R^2 refers to the autoregression models to determine statistical significance of nursing workforce changes over the course of time.

TABLE 3. Summary of Outcome Analysis

Outcome	Group	Change 1992–2000 (Baseline to 8 yrs After Implementation)	Model $R^{2\dagger}$
ALOS	Medical	↓ 25%	0.99*
	Surgical	↓ 18%	0.98*
CNS complications	Medical	↑ 738%	0.84*
	Surgical	↑ 1,766%	0.73*
Decubitus ulcers	Medical	↑ 88%	0.91*
	Surgical	↑ 258%	0.92*
DVT/PE	Medical	↑ 9%	0.70*
	Surgical	↑ 91%	0.88*
Upper GI bleed	Medical	↑ 51%	*0.89*
	Surgical	↑ 35%	*0.78*
Pneumonia	Medical	↓ 54%	*0.37*
	Surgical	↑ 29%	*0.72*
Sepsis	Medical	↑ 95%	0.88*
	Surgical	↑ 172%	0.72*
Shock	Medical	↓ 38%	*0.1*
	Surgical	↑ 16%	*0.6*
UTI	Medical	↑ 53%	0.90*
	Surgical	↑ 146%	0.90*
Phys/Met derangement	Surgical	↑ 1,224%	0.94*
Pulmonary failure	Surgical	↑ 296%	0.87*
Wound infections	Surgical	↑ 134%	0.97*
Mortality	Medical	↓ 37%	0.96*
	Surgical	=	*0.05*

*$P < 0.05$.
†Model R^2 refers to the autoregression models to determine statistical significance of outcome rate change over the course of time.
R^2 values in italics are not significant.

Reengineering's Influence on Outcomes and Nursing

The nursing workforce analysis showed decreases in the number of nurse FTEs and their associated hours worked, and an increase in skill mix. The outcomes analysis indicated a progressive and substantial increase in many of the adverse clinical outcomes rates after reengineering's implementation, a simultaneous decrease in ALOS, and decreasing or stable mortality rates. The final analysis examined whether changes in adverse outcome rates over time could be explained by changes in nursing workforce characteristics.

Table 4 summarizes autoregression analyses for each outcome by medical and surgical group and for each nursing workforce characteristic. There were statistically significant relationships between decreases in the size of the hospital nursing workforce, the number of nursing hours worked, and the increase in skill mix and several adverse outcome rates. Changes in the nursing workforce variables explained approximately 50% to 80% of the variance in CNS complications, decubitus ulcers, and sepsis rates among medical discharges and 50% to 96% of the variance in CNS complications, decubitus ulcers, DVT/PE, sepsis, UTI, physiological and metabolic derangement, pulmonary failure, and wound infections rates among surgical discharges.

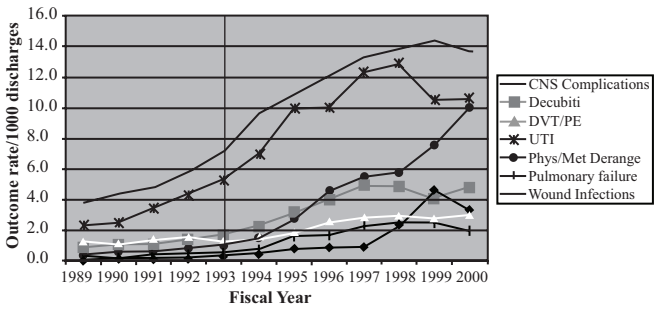

FIGURE 2. Total hospital outcomes per 1000 discharges, 1989 to 2000.

DISCUSSION

After health care reengineering began in 1993, medical and surgical nursing FTEs and nursing hours in NZ's public hospitals decreased 36%. Although the skill mix rose from 74% to 93%, the increase was more than likely influenced by the nursing profession's decision to phase out the EN role in hospitals rather than a conscious effort to employ a higher

TABLE 4. Change in Outcome Rate Explained by Change in Nursing

Outcome	FTEs Model R^2	Hours Worked Model R^2	Skill Mix Model R^2
Medical ALOS	0.93	0.95	0.97
Surgical ALOS	0.86	0.89	0.96
Medical CNS complications	0.80	0.83	0.75
Surgical CNS complications	0.70	0.72	0.62
Medical decubitus ulcers	0.53	0.53	0.73
Surgical decubitus ulcers	0.72	0.73	0.86
Medical DVT/PE	*0.25*	*0.26*	*0.47*
Surgical DVT/PE	0.82	0.83	0.91
Medical UGI Bleed	*0.30*	*0.31*	*0.50*
Surgical UGI Bleed	*0.10*	*0.10*	*0.21*
Medical pneumonia	*0.23*	*0.24*	*0.11*
Surgical pneumonia	*0.02*	*0.01*	*0.06*
Medical sepsis	0.77	0.76	0.56
Surgical sepsis	0.83	0.86	0.82
Medical shock	*0.41*	*0.45*	*0.41*
Surgical shock	*0.01*	*0.01*	*0.09*
Medical UTI	*0.37*	*0.37*	0.58
Surgical UTI	0.53	0.54	0.73
Surgical Phys/Met derangement	0.89	0.91	0.87
Surgical pulmonary failure	0.70	0.71	0.84
Surgical wound infections	0.80	0.82	0.96
Medical mortality	*0.01*	*0.01*	*0.03*
Surgical mortality	0.37	0.38	0.50

Model R^2 refers to the autoregression models to determine how much of the change in outcome rate may be the result of change in nursing workforce characteristics. R^2 values for nursing variables are similar due to high correlation among the nursing variables.
R^2 values in regular font indicate significance at $P \leq 0.05$; R^2 values in italic font indicate relationships that are not significant.

mix of RNs. The increase in skill mix was not large enough to overcome the decrease in FTEs and hours worked nor to compensate for the additional burden a decreasing length of stay poses on nursing staff. During the same time period, the cost effectiveness and process efficiency focus of reengineering resulted in a 20% decrease in overall ALOS and many clinical outcome rates increased, whereas mortality decreased or remained stable. The statistical relationships between changes in nursing and outcomes suggest that increased frequency of adverse patient outcomes was associated with decreases in the number of FTEs and nursing hours. These findings suggest that the introduction of NZ's health care reengineering policies significantly influenced the frequency of adverse outcomes among hospitalized patients with the effect occurring at the same time the nursing workforce decreased in size.

Reengineering has been shown to increase the demands on nurses' time by increasing workloads without providing new time and work-saving approaches and technologies.[24] Results of this study add to the body of evidence concerning the relationship between increases in nursing workloads and increases in adverse patient outcomes. The cost control and efficiency focus of hospital reengineering efforts often lead to declines in patients' lengths of stay and numbers of nurses, both of which were seen in NZ after 1993. The decline in ALOS after reengineering in NZ can be explained by the implementation of a DRG-based budgeting system designed to decrease the cost of care by decreasing lengths of stay. Declining ALOS increases the number of acute versus non-acute patient days, which increases nursing workload as overall patient acuity increases. At the same time, the decline in the number of nurses increases the number of patients per nurse. Lower staffing levels caused by reengineering and the associated increased nursing workload can lead to hurried, delayed, omitted, fragmented, or erroneous care.[25–27] Inadequate nurse staffing precipitates errors, reduces opportunities to detect errors before they occur, and increases miscommunications between staff.[28] The increased workload forces nurses to prioritize their interactions with patients, potentially causing them to omit important monitoring and clinical interventions that prevent adverse outcomes.[27,29]

Increases in adverse clinical outcomes and declines in mortality seem counterintuitive. In fact, there are several possible explanations for how the changes in the nursing workforce could be associated with stable and even improved hospital mortality rates. First, work prioritization may have led nurses to concentrate on lifesaving interventions rather than focus on clinical surveillance activities aimed at averting adverse clinical outcomes. Second, the shorter inpatient lengths of stay may have shifted patient deaths to settings outside the hospital such as long term care or the patient's home. Third, other lifesaving interventions such as new technology, medications, or other improvements in hospital procedures may have improved mortality rates from 1989 to 2000. Fourth, the aggregated analysis of yearly mortality rates for all NZ public hospitals may have smoothed the overall rate, failing to reflect what might be improvements in some facilities and concentrations of patient deaths in others. There is evidence, though not yet conclusive, that nurse staffing is associated with mortality; still, many factors influence hospital mortality.[12,30]

Two findings are inconsistent with those of other studies that analyzed nursing's influence on patient outcomes. The first has to do with the number of outcomes found to be sensitive to nursing. The nurse sensitive outcomes analyzed in this study were developed and tested by Needleman et al[11] in a cross-sectional study using U.S. hospital data. These investigators found 5 of the 11 associated with nurse staffing in medical and surgical populations while this longitudinal study found 3 were sensitive among medical patients and 8 were sensitive among surgical patients, suggesting more of the outcomes may be sensitive to nursing. The second inconsistent finding was that in this study adverse patient outcomes increased as skill mix increased whereas others have found adverse outcomes *decreased* when skill mix increased,[11,31,32] suggesting that in nurse work environments characterized by heavy workloads, overextended or absent nursing leadership, and poor morale, quality of patient care may not necessarily benefit from a richer skill mix.

Although NZ's databases of nurses and patient discharges offer unusually comprehensive and clean data for a large scale longitudinal study, there were still methodological limitations and interpretative problems attributable to both datasets that others conducting studies using administrative data have also identified.[7,11,33] In the NMDS data, secondary diagnosis codes do not specify whether a diagnosis was present on admission so despite the algorithms intent to identify only hospital-acquired adverse outcomes, some diagnoses may have been present on admission. An increasing numbers of secondary diagnoses codes recorded with each discharge over time increase the likelihood that an adverse outcome may be identified. This limitation was addressed by counting only the discharges with outcome-qualifying ICD codes in the first 3 secondary diagnosis spaces of the discharge abstract.

Methodological limitations with the nursing workforce data arose due to missing data and the inability to differentiate inpatient and outpatient hospital nurses. Others have developed models to account for the percentage of outpatient nurses in samples of inpatient and outpatient nurses. One group allocated staff based on inpatient to outpatient gross revenue.[8] Another group found that method substantially underestimated inpatient staffing and developed their own model based on hospitals' outpatient revenue share.[11] Revenue data were not available for the NZ discharges. Several models were constructed to determine how the inclusion of outpatient nurses in the sample would influence results. The only scenario that affected the relationship between nursing and outcomes was one in which outpatient nurse staffing dramatically decreases over the study years while smoothing the year to year variation in inpatient nurse hours and FTEs. A dramatic rise in the number of outpatient encounters (from 80,000 cases to more than 160,000 from 1993 to 2000) and evidence from the Ministry of Health that outpatient nurse staffing did not fluctuate dramatically with the changes in volume do not support the occurrence of this scenario (per-

sonal communication with Frances Hughes, RN, MA, DN, NZ Ministry of Health Chief Nursing Advisor, March 2005). Therefore, eliminating an arbitrary number of outpatient nurses would only decrease the numbers of sample nurses, thereby strengthening what are already strong and statistically significant relationships. The decision to eliminate EN employment in hospitals also undoubtedly masks how much of the overall decline in the number of ENs was attributable to reengineering.

Policy Implications

The study provides insight into unintended consequences of health care reengineering and market approaches in health care along with the importance of ongoing quality management during organizational change. Secondly, it highlights the value of using administrative datasets to identify potential systematic quality and safety problems within organizations particularly when other data are unavailable. Finally, it demonstrates that the current focus on patient safety and quality of care may be best addressed through an investment in nursing.

The IOM reports, *To Err Is Human: Building a Safer Health System, Crossing the Quality Chasm: A New Health System for the 21st Century*, and *Keeping Patients Safe: Transforming the Work Environment of Nurses*, raised the discussion about quality to the top of the health care agenda.[34–36] The findings from this study contribute to the continually growing body of evidence that nurses are integral in the delivery of safe patient care and that tinkering with nursing FTEs and hours without a monitoring mechanism may lead to significant quality problems.

ACKNOWLEDGMENTS

The authors thank Peter I. Buerhaus, PhD, RN, FAAN, for his comments on the manuscript.

REFERENCES

1. Leatt P, Baker GR, Halvorson PK, et al. Downsizing, reengineering, and restructuring: long-term implications for healthcare organizations. *Frontiers of Health Services Manage*. 1997;13:4–37.
2. Aiken LH, Clarke SP, Sloane DM. Hospital reengineering: does it adverse affect care and outcomes? *J Nursing Admin*. 2000;30:457–465.
3. Urden LD, Walston SL. Outcomes of hospital restructuring and reengineering: how is success or failure being measured? *J Nursing Admin*. 2001;31:203–209.
4. Shindul-Rothschild J, Long-Middleton E, Berry D. Where have all the nurses gone? Final results of our patient care survey. *Am J Nursing*. 1996;96:24–39.
5. Clifford JC. *Restructuring the Impact of Hospital Organization on Nursing Leadership.* Chicago: American Hospital Publishing, Inc.; 1998.
6. Malone BL, Keepnews D. Ensuring the future of nurses in clinical practice: issues and strategies for staff nurses and advanced practice nurses. In: Mason DJ, Leavitt JK, editors. *Policy and Politics in Nursing and Health Care, 3rd ed*. Philadelphia: W. B. Saunders Company; 1998:294–303.
7. Lichtig LK, Knauf RA, Milholland DK. Some impacts of nursing on acute care hospital outcomes. *J Nursing Admin*. 1999;29:25–33.
8. Kovner C, Gergen PJ. Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image*. 1998;30:315–321.
9. Sovie MD, Jawad AF. Hospital restructuring and its impact on outcomes: nursing staff regulations are premature. *J Nursing Admin*. 2001; 31:588–600.
10. Aiken LH, Sloane DM, Lake ET, et al. Organizational outcomes and inpatient AIDS care. *Med Care*. 1999;37:760–772.
11. Needleman J, Buerhaus PI, Mattke S, et al. *Nurse staffing and quality of care in inpatient units in acute care hospitals.* Boston, MA: Health Resources Services Administration; Contract No. 230-99-0021, 2001.
12. Aiken LH, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse burnout, and job satisfaction. *JAMA*. 2002;288: 1987–1993.
13. Hall LM, Doran D, Pink GH. Nurse staffing models, nursing hours, and patient safety outcomes. *J Nursing Admin*. 2004;34:41–45.
14. Gauld RD. Big Bang and the policy prescription: health meets the market in New Zealand. *J Health Politics*. 2000;25:815–844.
15. New Zealand Health Information Service. Available at: http://www.nzhis.govt.nz/stats/hospstats.html. Accessed August 23, 2005.
16. Traynor M. *Managerialism and Nursing: Beyond Oppression and Profession.* London: Routledge; 1999.
17. Howden-Chapman P, Ashton T. Public purchasing and private priorities for healthcare in New Zealand. *Health Policy*. 2000;54:27–43.
18. Hornblow A. New Zealand's health reforms: a clash of cultures. *Br Med J*. 1997;314:1892–1894.
19. State Sector Act of 1988, New Zealand Parliamentary Counsel Office. Available at: http://www.legislation.co.nz/browse_vw.asp?content-set=pal_statutes. Accessed August 23, 2005.
20. Employment Contract Act of 1991, repealed 2000.
21. Bamford A. *Leadership for culture change: generating new growth from old.* Doctoral dissertation, University of Technology, Sydney; 2004.
22. Coney S. Auckland: relentless unraveling of New Zealand's health-care system. *Lancet*. 1996;347:1825–1826.
23. Oermann MH, Huber D. Patient outcomes: a measure of nursing's value. *Am J Nursing*. 1999;99:40–48.
24. Kimball B. Health care's human crisis-Rx for an evolving profession. *Online Journal of Issues in Nursing,* 2004;9.
25. Heinrich, J. *Nursing workforce multiple factors create nurse recruitment and retention problems.* (Rep. No. GAO-01-912T). United States General Accounting Office: Testimony before the Subcommittee on Oversight of Government Management, Restructuring, and the District of Columbia, Committee on Government Affairs, U.S. Senate. Washington, DC: USGAO, 2001. Available at: www.gao.gov. Accessed August 23, 2005.
26. Unruh L. Licensed nurse staffing and adverse events in hospitals. *Med Care*. 2003;41:142–152.
27. Aiken LH, Clarke SP, Sloane, et al. Nurses' report on hospital care in five countries. *Health Affairs.* 2001;20:43–53.
28. Cho S. Nurse staffing and adverse patient outcomes: a systems approach. *Nursing Outlook*. 2001;49:78–85.
29. Cho S, Ketefian S, Barkauskas VH, et al. The effects of nurse staffing on adverse events, morbidity, mortality, and medical costs. *Nursing Res*. 2003;52:71–79.
30. Needleman J, Buerhaus P. Nursing staffing and patient safety: current knowledge and implications for action. *Int J Quality in Health Care*. 2003;15:275–277.
31. Blegan MA, Goode CJ, Reed L. Nurse staffing and patient outcomes. *Nursing Res.* 1998;47:43–50.
32. Aiken LH, Clarke SP, Cheung, et al. Educational levels of hospital nurses and surgical patient mortality. *JAMA.* 2003;290:1617–1623.
33. Iezzoni LI. *Risk Adjustment for Measuring Health Care Outcomes.* Chicago: Health Administrative Press; 2003:107–120.
34. Kohen LT, Corrigan J, Corrigan J, et al. *To Err Is Human: Building a Safer Health System.* Washington, DC: National Academy Press; 2000.
35. Institute of Medicine. *Crossing the Quality Chasm: A New Health System for the 21st Century.* Washington, DC: National Academy Press; 2001.
36. Institute of Medicine. *Keeping Patients Safe: Transforming the Work Environment of Nurses.* Washington, DC: National Academy Press; 2003.

