Hospital Nurse Staffing and Patient Outcomes:

A Report to the Minnesota Legislature

Hospital Nurse Staffing and Patient Outcomes

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The Honorable Tony Lourey
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The Honorable Tara Mack
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The Honorable Matt Dean
Chair, Health, Human Services Finance
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Dear Senator Sheran, Senator Lourey, Representative Mack, and Representative Dean:

As required by 2013 Minnesota Laws, Chapter 51—H.F. No. 588, sec. 2, this report presents findings from a study by the Minnesota Department of Health (MDH) about the relationship between hospital nurse staffing and patient outcomes.

In conducting the study, MDH:

- Convened an expert workgroup to obtain advice on study approach and methodology;
- Reviewed the existing literature on the relationship between hospital nurse staffing and patient outcomes; and
- Developed a research methodology and data collection approach.

In this study, MDH was unable to answer the question for the Minnesota health care environment directly through quantitative analysis. Available data sources for nurse staffing levels did not provide enough detail in the correct time period to perform a scientifically robust analysis. To conduct the analytic part of the study MDH requested the necessary staffing data to provide adequate detail from 39 hospitals. MDH received a response from only one facility.

A review of the substantial body of evidence, including many recent studies, indicates there is a positive association between levels of nurse staffing and certain patient outcomes. Higher levels of nurse staffing were shown to be correlated with lower patient mortality, reduced patient falls, and fewer drug administration errors.

At this point, available studies do not prove causal relationship, or indicate that changes in patient outcomes are solely the result of nurse staffing decisions; they also do not identify points at which staffing levels become unsafe or begin to have negative effects on outcomes.

If you have questions or concerns regarding this study, please contact Stefan Gildemeister, the State Health Economist, at 651-201-3554 or stefan.gildemeister@state.mn.us.

Sincerely,

Edward P. Ehlinger, M.D., M.S.P.H,
Commissioner of Health

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Introduction

The 2013 Minnesota Legislature directed the Minnesota Department of Health to study the correlation between nurse staffing and patient outcomes.[1] For this study, MDH:

- Convened an expert workgroup on study approach and methodology;
- Reviewed the research literature related to the association of hospital nurse staffing and patient outcomes; and
- Developed a research methodology and data collection approach.

In order to answer the question about the relationship of nurse staffing and patient outcomes directly for Minnesota hospitals, MDH had anticipated performing quantitative analysis with relevant Minnesota-specific data. MDH staff evaluated the suitability of publicly available data for answering the Legislature's questions, and determined that additional data would be necessary in order to conduct an analysis that was sufficiently robust. Although MDH made a direct data request to 39 Minnesota hospitals for more granular information to complement publicly available data,[2] we were ultimately unable to collect the needed data to produce a meaningful quantitative study.

Therefore, this report focuses on: (1) describing MDH's work with the expert workgroup it convened, (2) summarizing existing evidence from peer-reviewed research on the study topic, and (3) presenting how MDH assessed the available data and developed its analytic approach and data collection request.

When the law requiring this study passed in 2013, the broader context in testimony at the Legislature was related to adopting statewide requirements for hospitals to maintain certain ratios of nurses to patients. This study was not intended as an assessment of the effectiveness of nurse-to-patient ratios or its impact on patient outcomes.

Nurse Staffing and Patient Outcomes Workgroup

To inform the study approach and methodology, the Legislature directed MDH to convene a workgroup (Appendix B lists workgroup members, Appendix C provides the workgroup charge). It was comprised of experts with experience in direct patient care, nursing administration, nurse education and research, and patient safety. Key stakeholder groups such as the Minnesota Nurses Association and the Minnesota Hospital Association appointed their own representatives to the workgroup; other members were named by the Commissioner of Health.

The expert workgroup met five times between October 2013 and March 2014, during which time the group was asked to provide advice on the following five aspects of the study:

1. Nurse staffing measures to be considered in the study;
2. Patient outcomes measures that are sensitive to nurse staffing levels to be chosen for the study;
3. Other factors beyond nurse staffing that may affect patient outcomes and should be considered in the study;

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[1] See Appendix A for statutory language.
[2] MDH's data request from July 23, 2014 is available online:
http://www.health.state.mn.us/divs/hpsc/hep/nursestudy/hospdatacollection.html

4. Level of data required and granularity of data needed to produce a robust and high quality study; and
5. Potential data sources to draw on or complement through new data collection.

The workgroup had robust and passionate discussions that highlighted agreements and differences among members. Although MDH would have welcomed consensus, there were numerous topics and issues in which the workgroup members did not reach agreement; however, each member had the opportunity to express their opinion. Disagreements centered predominantly on collection of new data and the need for more detailed data on nurse staffing levels.

Meetings of the workgroup were public. Meeting materials, including presentations made by other experts to the group, were accessible via a webpage that MDH maintained for this project: http://www.health.state.mn.us/divs/hpsc/hep/nursestudy.

Key Feedback from the Workgroup

In framing its discussion, workgroup members and MDH first agreed that there was already a substantial existing body of evidence around the relationship between staffing and patient outcomes. However, workgroup members differed on their interpretation this evidence. Second, there was agreement that the study by MDH needed to be methodologically robust and recognize the complexities of staffing decisions as well as a range of factors beyond nurse staffing that may impact patient outcomes.

Specifically, early on in the discussion, members had general agreement that a high-quality study would need to attempt to take into consideration certain factors beyond basic staffing measures, including:

- Acuity or a measure of patient illness;
- Staffing mix and nursing intensity[3];
- Individual factors of nurses and other staff, including training, work experience and education;
- Role of float nurses[4] or other personnel that move between units and supplement existing staff;
- Facility characteristics such as size, technology, physical layout and geographic setting; and
- Factors that describe the culture in a facility and unit, including degree of nurse autonomy and communication between nurses and other staff.[5]

Throughout the workgroup process there were also many areas where workgroup members differed. Most importantly, there were differences of opinion as to the level of detail required to measure the volume of nurse staffing, such as the need to include different nurse skill levels and whether staffing should be from specific units of time or averages over longer time periods. There was also a lack of consensus as to which patient outcomes should be examined. Ultimately, these and other workgroup viewpoints offered MDH a diversity of perspectives in developing a Minnesota study alongside existing literature and strong scientific rationale.

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[3] Nursing intensity is a measurement used to quantify the amount of time needed to care for a patient.
[4] Float nurses are nurses that can work on different units of the hospital during a shift.
[5] Additional summary information on workgroup discussion is available online through meeting summaries (http://www.health.state.mn.us/divs/hpsc/hep/nursestudy/wkgrpmeetings.html).

Nurse Staffing Measures

In general, workgroup members expressed the view that nurse staffing measures should reflect the direct care provided to patients and that the form of measurement should be one that is commonly used, such as nurse hours per patient day. Certain members of the workgroup also emphasized that skill mix or the proportion of nursing staff that are registered nurses (RNs) is also an important factor to consider when analyzing patient outcomes.

Patient Outcomes Measures

The workgroup was asked to provide input on selecting appropriate patient outcomes that should be considered in the research. Workgroup members expressed some concern about the state of the science for measuring patient outcomes and challenges associated with creating a temporal link between outcome measures (which are often only reported annually) and staffing on a specific date. In reviewing a list of nurse-sensitive patient outcome measures aggregated by MDH, workgroup members agreed that relying on these measures identified by national experts associated with organizations like the National Quality Forum (NQF) and the U.S. Department of Health's Agency for Healthcare Research and Quality (AHRQ), reflected a sensible approach to quality measurement in the study (see Appendix D).

Data Granularity and Timeframe

Some members of the workgroup expressed concern about variability in staffing levels across time periods, including days of the week and nursing shifts and concluded that measures of average staffing over longer time periods would mask variability. The ability to ascertain the existence of variation in nurse staffing was seen as a key requirement of conducting the study.

Others commented that good quality research should ensure that time periods for patient acuity, patient outcomes and nurse staffing correspond in order to draw valid conclusions. These members also noted that finding data that reflects the same time period, and the needed level of granularity, for each of these factors could prove challenging.

Finally, some members expressed concerns about expectations for granular staffing data because of the potential that new data collection from hospitals could not always be matched with outcome data at similar levels of granularity.

Data Sources

There were differences of opinion among the workgroup members on the need to collect additional nurse staffing data from hospitals for the study. Some members felt that any data collection effort needed to include nurse staffing measurement at the unit and shift-level. Others voiced an opinion that existing, publicly available data would be sufficient for answering the questions posed by the Legislature, and that requesting daily or shift-level nurse staffing measures would be too burdensome to hospitals.

Still others suggested that data collection was needed, but data sources should be anchored in a way that is practical, sensitive to hospital data-gathering burden, and be used in a method that would hold up under review by research experts. This third viewpoint recognized that shift-level nurse staffing data could not typically be linked to measures of patient acuity and outcomes, as those generally exist at the encounter (stay) or day level. This suggested nurse staffing measurement at the day level.

Other Factors

The majority of members thought it was important to consider relevant context, such as the degree to which work culture and nurse autonomy differed across units and facilities, as well as factors such as patient complexity or acuity and patient demographics. Members recognized that a ready-made measurement framework and data sources do not currently exist for all of these metrics, although some are under development. Some members also noted that it was important to recognize in the analysis changes in activity in care units, including work performed by nurses to admit, discharge and transfer patients. Members thought conducting a study without this activity could mask typical measures of nurse workload. Other members felt that nurse staff satisfaction, use of health information technology, and voluntary staff turnover were factors more readily available and suggested the study draw on them in the analysis.

Finally, other advice from workgroup members recommended that MDH not "reinvent the wheel" and that previous studies had made substantial progress over decades of research to generalize findings in addressing the Legislature's questions. Members encouraged MDH to review the existing literature, including meta-analyses and systematic reviews by organizations such as the RAND Corporation, the National Academy of Sciences, the Institute of Medicine (IOM), researchers at the Evidence-based Practice Center at the University of Minnesota and the National Institute for Clinical Effectiveness in the United Kingdom (relying overwhelmingly on research in the United States).

Review & Synthesis of Literature

Decades of research on the correlation between nurse staffing and patient outcomes have produced numerous studies, many of which were analyzed in four systematic reviews (Griffiths et al., 2014, Kane et al., 2007, Penoyer, 2010 and Shekelle, 2013) examining the relationship between nurse staffing levels and patient outcomes. Evidence from research using the strongest study design suggests that there is an inverse relationship between lower nurse staffing levels and the following patient outcomes:

- Patient mortality,
- Failure to rescue from surgical complications, and
- Falls in the hospital[6]

There is also strong evidence that other outcomes such as drug administration errors, missed nursing care and patient length of stay are linked to lower nurse staffing levels. There are some studies which find mixed or no evidence of the above outcomes; these studies are generally of a less robust study design.

While the literature has demonstrated the correlation between nurse staffing volumes and certain outcomes, it has not yet established an increase in nurse volume will inevitable product changes in outcomes – or the pretense of a causal relationship. In addition, the published evidence doesn't provide specific nurse staffing levels that will lead to certain patient outcomes, or suggest particular staffing models that might be more effective in improving patient outcomes. While more recent studies have used a stronger research design, many studies suffer from data limitations that make findings less valid and applicable to Minnesota hospitals.

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[6] The finding of an inverse relationship indicates that there is a correlation between variables such that outcomes would improve with increased nurse staffing volume.

Search Strategy

Conducting a comprehensive, systematic review of the evidence on nurse staffing and patient outcomes was considered duplicative given the number of recent systematic reviews (Griffiths et al., 2014, Kane et al., 2007, Penoyer, 2010 and Shekelle, 2013). Therefore, a "review of reviews" was conducted to examine methodological decisions, results, and potential gaps in the research. Second, an updated literature search was conducted to gather more recent studies not included in the systematic reviews. The updated search identified 217 titles. From these titles, six new articles were selected for complete review after being identified as germane to the study. Appendix E provides additional details.

Evidence on Nurse Staffing and Patient Outcomes

All four systematic reviews found low nurse staffing levels to be associated with higher patient mortality and failure to rescue (Griffiths et al., 2014, Kane et al., 2007, Penoyer, 2010, and Shekelle, 2013). Even studies with the most robust designs, which closely match time periods for nurse staffing levels to patient outcomes, found significant or nearly significant evidence for the association between nurse staffing volume and patient mortality (Needleman et al., 2011), as well as failure to rescue (Talsma et al., 2014). Griffiths et al., 2014 found evidence suggesting that low nurse staffing was associated with higher rates of patient falls in the hospital. Kane et al., 2007 and Shekelle, 2013 found research on this dynamic to be inconsistent, with some studies showing associations while other studies did not, but these systematic reviews included less robust study designs.

Beyond patient health outcomes, there are patient process outcomes that have been found to be associated with lower nurse staffing levels. Griffiths et al., 2014 found evidence from several studies suggesting that higher rates of drug administration errors and missed nursing care were associated with lower nurse staffing levels. Three of the systematic reviews found evidence suggesting that lower nurse staffing levels were associated with longer patient stays in the hospital (Griffiths et al., 2014, Kane et al., 2007, and Shekelle, 2013). There is also evidence that higher nurse staffing levels were associated with a reduced length of stay (de Cordova et al., 2014).

Other patient outcomes routinely used to measure patient safety such as pressure ulcers and hospital acquired infections have inconsistent or less strong evidence supporting an association with low nurse staffing levels (Griffiths et al., 2014; Choi and Staggs 2014; Park et al., 2014; Bae et al., 2014). For more information on patient outcomes, see Table E.2 in Appendix E for additional information.

Evidence Limitations

Despite the substantial body of research on the topic, there are still limitations to the evidence and data. The three expert panels convened by the National Academy of Sciences Institute of Medicine (IOM) in 1996, 2004, and 2011 noted that there is room for improvement in research, and indicated the following three strategies should be used when designing studies of nurse staffing and patient outcomes:

- Include large samples sufficient to produce evidence (IOM, 1996 & IOM, 2004);
- Investigate nurse staff skill mix and patient outcomes (IOM, 1996 & IOM, 2011); and,
- Conduct analysis at the hospital unit level rather than the entire hospital (IOM, 2004).

More recent research on statutorily mandated nurse staffing levels in California offer additional insight into possible causality, yet there have been no randomized controlled trials or studies using random assignment of nurse staffing levels to certain hospitals to study patient outcomes. Without this specific approach, it is not possible to determine the most appropriate staffing configuration or at which level nurse staffing is correlated with better or worse patient outcomes.

While most of the studies in the systematic reviews as well as the MDH review of the literature adhere to the parameters laid out by IOM, many studies still exist that are less than ideal due to data constraints. For example, there are many older studies that were conducted at the hospital level where specific nurse staffing levels from one unit of the hospital are attributed to patient outcomes from another unit and vice-versa. Similarly, there are studies that rely on staffing averages across an entire year and tie them to a patient outcome occurring in a short period of time. These studies result in attributing staffing across a hospital to patients in specific units, instead of a more precise unit-specific and shorter time frame analysis (Clarke and Donaldson, 2008). This may mask true associations between staffing and patient outcomes by diluting variability.

Minnesota Study Approach

MDH developed its approach to conducting quantitative analysis of the relationship between nurse staffing and patient outcomes after carefully considering expert feedback from the workgroup members, reviewing the literature, consulting with national experts who have conducted similar research, and examining available data.

In this process, MDH endeavored to conduct a study of high scientific rigor that was analytically independent while taking into account data collection burden, available resources, and timeline.

For the study, MDH evaluated three data domains, following guidance from the workgroup: (1) nurse staffing measurement; (2) measurement of patient outcomes; and (3) measurement of patients' acuity and other relevant variables.

Following this evaluation, MDH identified quality measures to use in the study, data sources to employ to adjust for patient acuity, and data needs to fill related to nurse staffing information.

Nurse Staffing Measurement

The criteria for selecting nurse staffing measures and corresponding data sources included the following:
- Nurse staffing measurement must allow for distinction between RN and other staff to identify variability in skill mix and its effect on patient outcomes;
- Data sources for nurse staffing must be from the same time period as patient outcomes data;[7]
- Staffing measures must adhere to commonly agreed-upon standards used by hospitals;
- Staffing data must tie closely to direct care hours provided to patients and ideally be linked to specific care service units; and,
- Data must be sufficiently detailed to not mask potential variability in staffing levels.

MDH reviewed two available data sources that contain nurse staffing information for potential use in the study (see Table 1). One is the Hospital Annual Report (HAR) collected by the Minnesota Hospital Association (MHA) under contract with the Minnesota Department of Health. It contains hospital-level information on utilization, finances and services. The other data source is hospital data collected and

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[7] The requirement that studies of association rely on variables from the same time period (or measurements in similar units) intends to limit the potential to incorrectly infer relationships between variables when they are actually the result of coincidence or the effect of a third variable – this is called spurious relationship in statistics.

aggregated by MHA under the 2013 Staffing Plan Disclosure Act (SPDA).[8] The SPDA requires public reporting of core staffing plans for each patient care unit and, on a quarterly basis, reporting of the *actual* direct patient care hours per patient and unit by each Minnesota hospital to MHA.

We found neither data source sufficient for conducting this legislative study with appropriate rigor expected by the expert workgroup and the Legislature.

The weakness of the HAR, preventing its use for the study, is that nurse staffing data is reported for the whole institution (spanning inpatient and outpatient care) instead of being specific to care units. In addition, staffing data exists as one measure for a complete 12-month period, instead of being specific to a given day. Together, this inhibits the ability to associate patient and unit-level outcome metrics with variation in nurse staffing. For instance, in order to assess whether higher rates of patient mortality in an intensive care unit (ICU) on a particular day in a year are associated with a level of nurse staffing at that time, nurse staffing data must be available at the ICU-level for that given day.[9]

The MHA Staffing Plan reports are in some ways more granular than other available data – they include nurse staffing in two categories for each hospital care unit – but for the purpose of studying the association between staffing and patient outcomes, they are characterized by three problems:

1. **By being limited to one data point per quarter for each hospital unit, the data mask day-to-day variation in staffing, greatly reducing the ability to identify any relationship between staffing and outcomes.** If there was a relationship between nurse staffing and patient outcomes, it would only be detectable if the underlying variation were preserved. During a quarter there can be substantial changes in patient volume and acuity, and in the nurse staffing levels needed to serve those patients. An average over a long period of time would remove any high or low levels of nurse staffing in relation to patients. By averaging nurse staffing across a quarter, the statistical "signal" contained in the nurse staffing/patient outcome relationship, if it exists, is so diluted that it cannot be meaningfully detected across the small number of Minnesota hospitals.

2. **The data do not allow an analysis of skill-mix differences across units or facilities.** While the data distinguish between nursing hours and hours worked by other assistive personnel, they do not allow for distinction between RNs and LPNs or between classes of assistive personnel. This might result in incorrectly attributing patient outcome differences to differences in nurse staffing volume when they might actually be the result of differences in staff experience because of the mix of staff training, education and roles.

3. **The time period of the nurse staffing data does not correspond with that of available data to calculate patient outcomes and adjust for patient acuity differences.** As discussed later, any analysis testing the correlation between nurse staffing and patient outcomes across care units in Minnesota hospitals must account for differences in patient complexity, or acuity, to make fair comparisons of patient outcomes. In order to avoid incorrectly finding associations between variables, data need to originate in the same reporting period. Currently available data to measure patient acuity that would also be used for calculating certain patient outcomes are

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[8] 2013 Minnesota Session Laws, Chapter 51—H.F. No. 588
[9] Additional weaknesses of the data for use in the study include that it is based on full-time equivalency, which counts so-called "unproductive hours" like sick and vacation leave and would bias the analysis.

from calendar year 2013.[10] Comparing nurse staffing for 2014 to quality performance in an earlier year would not be a meaningful comparison, because if there is a relationship between staffing and outcomes it cannot work backward (i.e. staffing in 2014 cannot be associated with outcomes that already occurred in 2013).

Table 1: Potential Available Data Sources for Nurse Staffing

	MDH Hospital Annual Report (HAR)	MHA Staffing Reports First and Second Quarter 2014
Data Vintage	Hospital fiscal year for 2012[1]	January-June 2014[2]
Staffing Metric	Average full-time equivalent employees (FTE) for 365 days	Average direct care nurse hours for 90 days
Skill Mix	Registered Nurses, Licensed Practical Nurses, Nursing Assistants/Aides	All Licensed Nurses, Other Assistive Direct Care Personnel
Unit of Analysis	Facility-level data combines inpatient and outpatient services	Unit-specific, includes 45 unit categories
Staffing Measure Denominator	Adjusted patient days (to account for outpatient activity)	Average daily patient census and observation hours for 90 days
Hospitals Included	127 Acute Care Hospitals & 16 Specialty Hospitals	127 Acute Care Hospitals & 16 Specialty Hospitals

[1] As fiscal years vary across hospitals, time periods of the data may vary by as much as 10 months.
[2] This was the status of the available data at the time of drafting this report.

To conduct a valid study of the correlation between nurse staffing and patient outcomes in Minnesota hospitals, MDH concluded that an analysis would require nurse staffing data for calendar year 2013, specific to certain key hospital care units and summarized for each day. This would mask known variation in staffing at the shift level, but because patient outcome data cannot generally be calculated at the shift level, the additional precision in staffing volume would not be helpful.[11]

As data that met these requirements are not publicly available, MDH developed a request for collection of new data from Minnesota hospitals in July, 2014. After working with stakeholders MDH developed data collection materials to instruct hospitals in reporting the necessary nurse staffing data.[12] In finalizing the data collection request, MDH sought to obtain minimally necessary data for a robust study while limiting reporting burden for hospitals through the following strategies:

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[10] MDH would be using the Minnesota Hospital Discharge Database it purchases from the Minnesota Hospital Association. This database experiences a lag of between 10 and 12 months that is generally associated with aggregating the data from Minnesota's hospitals and performing basic quality checks on it.
[11] This would satisfy one best-practices criterion established by the IOM in one of its topic-specific reviews, in which it recommended any analysis be conducted at the patient level. Institute of Medicine. (2004). Committee on the Work Environment for Nurses and Patient Safety. Ann Page, Editor. Washington DC: The National Academies Press.
[12] A copy of the request sent to hospital administrators can be found in Appendix F. Nurse staffing data request materials can also be found online:
http://www.health.state.mn.us/divs/hpsc/hep/nursestudy/hospdatacollection.html

- Wherever possible, the request used existing definitions for data elements developed by MHA for its data collection, to avoid requiring hospitals to parse data in new ways.
- The request was limited to hospitals with sufficient nurse staff and patient volume to be meaningfully included in the study (39 of 143 hospitals).
- The request pared down the list of care units for which reporting was required from the 45 unit types collected by MHA to three adult general care categories, including intensive care units, step-down units, and medical-surgical units. Definitions were aligned with those used by MHA.

MDH heard concerns about its data collection strategy from two stakeholder groups, the Minnesota Nurses Association (MNA) and the Minnesota Hospital Association (MHA).

The MNA's concerns about data collection and the MDH analytical approach included:

- MDH is not conducting shift-level analysis.
- The Agency is missing the opportunity to assess the relationship between nurse staffing and outcomes in rural settings by not including smaller hospitals in the study.
- MDH should incorporate patient acuity and nursing care needs of individual patients into its analysis.
- The study should include all direct care hours for float nurses, managers, and assistive personnel and not only those working 50 percent of their time on a given unit to ensure accurate staffing measurement.

The MHA's concerns about data collection and the MDH analytical approach included:

- MHA did not receive notification until a month before the request was made to hospitals, and the requested information may not have been available even if 6 to 12 months' notice was given.
- The decision to request data from only of a subset of Minnesota hospitals, excluding Critical Access Hospitals and other smaller facilities, would result in a flawed picture of staffing and the staffing/outcome relationship.
- MDH did not adequately consider the reporting burden associated with the data collection request.
- Collecting data beyond recently available MHA staffing report data would be irrelevant because patient outcomes generally are only available hospital-wide and on an annual basis.
- MDH was not sufficiently clear how it was planning to use the data and how the data was protected.
- MDH might not have the legal authority to request the information, despite its public record, including on fiscal notes, about how it would conduct the study and its broad statutory authority to request data from providers.
- Determining a majority of time for float nurses, managers, and assistive personnel would be difficult.

MDH considered the concerns raised by MNA and MHA, but felt this approach was reasonable, necessary and consistent with the Legislative direction. As mentioned earlier, data collection at the shift level would not have produced additional precision in the study because outcome data do not generally exist at that level of granularity. As noted below, with outcomes available at the patient stay level, there is not an issue with outcomes being summarized on an annual basis. In addition, patient acuity and care needs are taken into account by conducting separate analysis for intensive care patients, and by considering patient factors.

Concerns raised about including managers, float nurses and assistive personnel were addressed by including those that spent the majority of their time in direct patient care in the identified units. MDH did not want to include hours that were not direct care, or took place outside of the three identified unit types.

Smaller hospitals were excluded from data collection because of recommendations from the literature to exclude from high-quality studies hospitals with an average daily census of fewer than 20 patients or an occupancy rate below 20 percent in order to avoid drawing conclusions from unstable staffing patterns.[13] In order to reduce reporting burden, MDH limited the number of hospitals from which to collect data, communicated a willingness to work with hospitals to better understand the need for the data and expressed flexibility about concerns around reporting deadlines.

MDH submitted its request for data to hospitals on July 23, 2014 (see Appendix F). MHA informed the Commissioner on Aug 6, 2014 that it had advised hospitals not to fill the data request. By the middle of September, 2014, MDH had received data from only one facility, and determined that it could not move forward with the planned analysis.

Patient Outcomes Measurement

As noted previously, MDH determined that the preferred level of analysis for a study of this type was at the patient level, based on best practices recommended by the Minnesota Evidence-based Practice Center.[14] This would be accomplished by analyzing patient outcomes at the hospital stay level that could be matched to nurse staffing levels in the same unit type for the same time period.[15]

Selection criteria for outcome measures to be used in the study included the following:
- Inclusion in the National Quality Forum (NQF) list of nationally standardized nurse-sensitive patient outcomes measures or outcomes demonstrated to be sensitive to nurse staffing in the literature;[16]
- High enough frequency in preliminary analysis to produce stable results;
- Patient-level data source with an ability to control for patient risk factors;
- No documented flaws in definitions and tracking for specific measure; and,
- The measure can be computed (or is otherwise available) for the time period of the study.

MDH determined that the following list of patient outcomes measures met all of these criteria:
- Failure to rescue (death among surgical patients with complications),
- In-hospital mortality,
- Postoperative sepsis, and
- Select infections[17] due to medical care for intensive care unit patients.

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[13] See Needleman J, Buerhaus P, Mattke S, et al. (2002).
[14] See Kane RL, Shamliyan T, Mueller C, et al. (2007).
[15] A description of unit types can be found in the nurse staffing data request materials found on the following MDH website: http://www.health.state.mn.us/divs/hpsc/hep/nursestudy/hospdatacollection.html
[16] National Quality Forum. (2004). National voluntary consensus standards for nursing-sensitive care.
[17] These infections include catheter-associated urinary tract infections and catheter-associated bloodstream infections.

Other outcomes excluded for the reasons described in Table 2 below:

Table 2: Nurse-Sensitive Patient Outcomes Not Selected

Patient Outcome	Reason for Exclusion
Drug Administration Errors	Very low frequency in preliminary analysis of hospital administrative discharge data.
Patient Falls with Injury in the Hospital	Very low frequency in preliminary analysis of hospital administrative discharge data.
Pressure Ulcers	Very low frequency in preliminary analysis of hospital administrative discharge data as well as documentation questioning the reliability of accurate tracking in administrative discharge data (Houchens et al., 2008 and Polancich et al., 2006).
Ventilator Associated Pneumonia	Ventilator associated pneumonia was excluded because the condition is difficult to define and track, and the United States Centers for Disease Control recently revised case definitions.

The data source that MDH determined to be best suited for supplying this information was the 2013 Minnesota hospital administrative discharge data (MNHDD) from the 39 hospitals identified to supply daily nurse staffing data. In planning the study, it was unclear if discharge data from the first two quarters of 2014 would be available in time to conduct a study; ultimately the data were not available in sufficient time to prepare the study during 2014.

Patient Acuity and Other Factors

Both the expert workgroup and a large body of research recognize that there are factors beyond nurse staffing that may directly influence the outcome of patient care. A summary of factors suggested by the workgroup can be found on the MDH nurse staffing levels and patient outcomes website in a workgroup summary prepared by facilitators of the workgroup that is also available online.[18] After examining the literature and considering challenges associated with appropriately measuring these factors, including availability of data and existence of standardized definitions, MDH identified the following factors to use in its analysis:

- Patient acuity and co-occurring medical conditions,[19]
- Patient demographic factors including age and gender,
- Hospital case mix or the mix of patient complexity (nursing intensity),
- Hospital size,
- Patient turnover[20] (number of admissions, discharges and transfers),and

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[18] The website can be found here: http://www.health.state.mn.us/divs/hpsc/hep/nursestudy/index.html.
[19] Many workgroup members familiar with patient acuity software provided feedback to MDH that there is no common acuity software system throughout Minnesota hospitals; therefore, it may be impossible to have standardized points of data and definitions. Even if there are similar data, it was noted that different software systems have proprietary methods for determining patient care needs.
[20] See Park SH, Blegen MA, Spetz J et al. (2012).

- Hospital factors, including geography, the extent to which a facility serves as a safety-net hospital, if the facility provides medical education, and if the facility maintains unique technically complex equipment.

MDH planned to use administrative claims data (MNHDD), as well as facility-level summary data to incorporate these adjustments into the analysis. Patients' corresponding age, gender, condition/ acuity, and co-occurring medical conditions would be used to predict the probability of experiencing an outcome of interest. This way, events can be compared more fairly since not all patients have the same likelihood of having one or more of the selected patient outcomes. In addition, MDH would use patient diagnostic and hospital service level information to estimate needed nursing care or "nursing intensity"[21] for specific hospital unit types. Analytically, this would be used to adjust nurse staffing hours along measures of patient complexity. For instance, a group of nurses on an intensive care unit may have fewer patients, but these patients require more nursing care attention for a variety of reasons.

Other relevant factors identified by the workgroup and in the literature, such as nurse education; nurse experience levels; nurse autonomy; the availability of contract and float nurses, non-nurse ancillary staff, and rapid response teams were not included by MDH in its analytic approach for two reasons:

1. There was no consistent existing source for these data, and MDH wanted to limit the data collection burden.
2. MDH found that some of these metrics still lacked agreed-on measurement frameworks or definitions, and were not consistently tracked in the industry.

Conclusion

Nationally and in Minnesota, there has been a strong interest in better understanding the relationship between nurse staffing and patient outcomes in an inpatient setting. MDH's review of the extensive literature found strong evidence linking lower nurse staffing levels to higher patient mortality, failure to rescue and falls in the hospital. There is also strong evidence that other care process outcomes such as drug administration errors, missed nursing care and patient length of stay are linked to lower nurse staffing levels. The evidence for other outcomes, such as pressure ulcers and hospital acquired infections, is inconsistent.

More generally, despite the decades of literature available, there were many studies that were hampered by limited data availability and lack of granularity. In addition, while the literature is extensive, there are only seven studies that link patient outcomes to nurse staffing levels at the time of the outcome events rather than using an average over a long period of time.

To conduct work specific to Minnesota's health care environment, as required by the Legislature, MDH designed and planned to perform an empirical study using data specific to Minnesota. In designing this study, MDH took input from the workgroup; developed evidence-based criteria for the types of outcome and staffing data that would be needed to conduct a robust analysis; and evaluated whether existing data sources were suited for this work. MDH determined that publically available data on nurse staffing levels would not meet the necessary criteria for a study of this nature, and requested needed data from

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[21] This calculation would be done using "nursing intensity weights" originally developed by Ballard et al., 1993 and updated to more recent diagnosis related groups for each patient as described in Mark and Harless, 2011.

a subset of hospitals. We only received data from one facility, and were not able to complete the planned analysis. Thus, MDH's work to study the correlation between nurse staffing and patient outcomes was constrained to describing the workgroup process, synthesizing the literature on the topic and presenting an analytic framework, together with describing data requirements, for conducting robust empirical research.

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Talsma A, Jones K, Guo Y, Wilson D, & Campbell DA. (Sep. 2014). The Relationship Between Nurse Staffing and Failure to Rescue: Where Does It Matter Most? *Journal of Patient Safety;* 10(3)133-9.

Appendix A

2013 Minnesota Session Laws, Chapter 51—H.F. No. 588

An act relating to health; requiring a hospital staffing report; requiring a study on nurse staffing levels and patient outcomes; appropriating money.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MINNESOTA:

Section 1.

[144.7055] STAFFING PLAN DISCLOSURE ACT.

Subdivision 1. **Definitions.** (a) For the purposes of this section, the following terms have the meanings given.

(b) "Core staffing plan" means the projected number of full-time equivalent nonmanagerial care staff that will be assigned in a 24-hour period to an inpatient care unit.

(c) "Nonmanagerial care staff" means registered nurses, licensed practical nurses, and other health care workers, which may include but is not limited to nursing assistants, nursing aides, patient care technicians, and patient care assistants, who perform nonmanagerial direct patient care functions for more than 50 percent of their scheduled hours on a given patient care unit.

(d) "Inpatient care unit" means a designated inpatient area for assigning patients and staff for which a distinct staffing plan exists and that operates 24 hours per day, seven days per week in a hospital setting. Inpatient care unit does not include any hospital-based clinic, long-term care facility, or outpatient hospital department.

(e) "Staffing hours per patient day" means the number of full-time equivalent nonmanagerial care staff who will ordinarily be assigned to provide direct patient care divided by the expected average number of patients upon which such assignments are based.

(f) "Patient acuity tool" means a system for measuring an individual patient's need for nursing care. This includes utilizing a professional registered nursing assessment of patient condition to assess staffing need.

Subd. 2. **Hospital staffing report.** (a) The chief nursing executive or nursing designee of every reporting hospital in Minnesota under Minnesota Statutes, section 144.50, will develop a core staffing plan for each patient care unit.

(b) Core staffing plans shall specify the full-time equivalent for each patient care unit for each 24-hour period.

(c) Prior to submitting the core staffing plan, as required in subdivision 3, hospitals shall consult with representatives of the hospital medical staff, managerial and nonmanagerial care staff, and other relevant hospital personnel about the core staffing plan and the expected average number of patients upon which the staffing plan is based.

Subd. 3. **Standard electronic reporting developed.** (a) Hospitals must submit the core staffing plans to the Minnesota Hospital Association by January 1, 2014. The Minnesota Hospital Association shall include each reporting hospital's core staffing plan on the Minnesota Hospital Association's Minnesota Hospital Quality Report Web site by April 1, 2014. Any substantial changes to the core staffing plan shall be updated within 30 days.

(b) The Minnesota Hospital Association shall include on its Web site for each reporting hospital on a quarterly basis the actual direct patient care hours per patient and per unit. Hospitals must submit the direct patient care report to the Minnesota Hospital Association by July 1, 2014, and quarterly thereafter.

Sec. 2. **STUDY.** The Department of Health shall convene a work group to consult with the department as they study the correlation between nurse staffing levels and patient outcomes. This report shall be presented to the chairs and ranking minority members of the health and human services committees in the house of representatives and the senate by January 15, 2015.

Sec. 3. **APPROPRIATIONS; NURSING STAFFING.** $187,000 in fiscal year 2014 and $65,000 in fiscal year 2015 are appropriated from the general fund to the commissioner of health for the completion of the study in section 2. This is a onetime appropriation.

Presented to the governor May 8, 2013

Signed by the governor May 9, 2013, 3:45 p.m.

Appendix B

Nurse Staffing & Patient Outcomes Workgroup Membership

Workgroup Members

Workgroup members represented a range of perspectives and areas of expertise. Members included:

- **Shirley Brekken**, RN, Executive Director - Minnesota Board of Nursing (*Nominated by the Commissioner of Health*)

- **Connie Delaney**, PhD, RN, Dean - University of Minnesota School of Nursing (*Nominated by the Commissioner of Health*)

- **Marie Dotseth**, MHA, Executive Director - Minnesota Alliance for Patient Safety (*Nominated by the Commissioner of Health*)

- **Linda Hamilton**, RN, President/RN - Minnesota Nurses Association/Minneapolis Children's Hospital – NICU (*Nominated by the Minnesota Nurses Association*)

- **Betsy Jeppesen**, RN, Vice President, Program Integrity - Stratis Health (*Nominated by the Commissioner of Health*)

- **Sandra "Mac" McCarthy**, DNP, Chief Nursing Officer - Essentia Health - East Region (*Nominated by the Minnesota Hospital Association*)

- **Christine Milbrath**, RN, EdD, Associcate Professor, Graduate Programs Director - Metropolitan State University (*Nominated by the Commissioner of Health*)

- **Steven Mulder**, MD, President and CEO - Hutchinson Health Region (*Nominated by the Minnesota Hospital Association*)

- **Maribeth Olson**, MA, Chief Nursing Officer - Mercy Hospital - Allina Health (Nominated by)

- **Robert Pandiscio**, RN, Staff Specialist - Minnesota Nurses Association (*Nominated by the Minnesota Nurses Association*)

- **Sandy Potthoff**, PhD, Associate Professor - University of Minnesota School of Public Health (*Nominated by the Commissioner of Health*)

- **Eric Tronnes**, RN, Staff Nurse, Ortho/Board member - Abbott Northwestern/Minnesota Nurses Association (*Nominated by the Minnesota Nurses Association*)

- **Vonda Vaden Bates**, Senior Consultant, Patient Representative (*Nominated by the Commissioner of Health*)

Appendix C

Nurse Staffing & Patient Outcomes Workgroup Charge

Workgroup Purpose and Formation

In 2013, the Minnesota Legislature directed the Minnesota Department of Health (MDH) to study the correlation between nurse staffing levels and patient outcomes (Laws of Minnesota 2013, chapter 51, section 2). The law also requires MDH to convene a workgroup to consult with the department in the process of conducting the study.

Recognizing that the role of the group is to advise on a legislative study on the relationship between staffing and patient outcomes (due in January 2015), MDH sought out individuals for the workgroup who could bring a strong background and expertise on methodological issues, hold operational knowledge and have a deep understanding of data that might be useful for such a study.

The recruitment of workgroup members was assisted by input from the community and interested parties that have direct experience in developing staffing plans and delivering patient care. For example, the Minnesota Hospital Association and Minnesota Nurses Association both submitted information for five workgroup candidates of which three were selected from each group. Other workgroup members were selected based on expertize in patient safety, quality improvement, as well as knowledge data and methodological necessary to conduct a study.

Workgroup Scope

What's in: The workgroup will consult with MDH in the areas of:

- Study methodology (including whether the study is conducted across patient groups or across institutions, whether and how to control for external factors such as acuity, etc.);
- Metrics of patient outcomes to be considered in the study;
- Data necessary and reasonably available for analysis; and
- Level of data granularity (such as shift, unit, or daily averages) and licensure levels.

What's out: The scope of this workgroup does not include weighing in on whether nurse staffing levels are currently adequate in Minnesota hospitals, or whether nurse staffing ratios or other approaches to fixing the patient/provider ratio should be legislatively mandated.

Workgroup responsibilities:

The workgroup's responsibility is to consult with MDH in the development of a nurse staffing and patient outcomes study. The workgroup will bring expertise and evidence to the discussion, provide examples and approaches to data collection, and advise MDH on considerations related to study methodology and execution.

MDH Hospital Nurse Staffing Study Website [Link to MDH website]

Meeting Dates and Material [Link to MDH website]

Appendix D
List of Potential Nurse-Sensitive Patient Outcome Metrics

Measure Name	AHRQ Patient Safety Indicators	NQF Core Measures	ANA National Database of NQI	MHA Hospital Engagement Network	Potential Currently Available Data Source
PATIENT OUTCOME MEASURES					
Death in low mortality DRG (PSI 02)	X				MNHDD CY 2013
Decubitus/pressure ulcer (PSI 03)	X	X	X	X	MNHDD CY 2013
Failure to rescue (PSI 04)	X	X	X		MNHDD CY 2013
Postoperative PE or VTE (PSI 12)	X			X	MNHDD CY 2013
Infection due to medical care					
Central line catheter associated blood stream infection (PSI 07)	X	Only ICU		X	MNHDD CY 2013
Septicemia/blood stream infection (PSI 13)	X			X	MNHDD CY 2013
Urinary tract infection (UTI)		Only ICU	X		MNHDD CY 2013
Urinary catheter associated UTI		Only ICU		X	MNHDD CY 2013
Ventilator associated pneumonia		Only ICU		X	MNHDD CY 2013
Nosocomial infection (any)					MNHDD CY 2013
Patient falls prevalence		X	X		
Patient falls with injury		X		X	MNHDD CY 2013
Readmissions				X	MNHDD CY 2013
Adverse drug events				X	MNHDD CY 2013
Shock or cardiac arrest					MNHDD CY 2013
CARE PROCESS MEASURES					
Nurse staffing skill mix		X	X		HAR FY 2012 (Inpatient and Outpatient)
Total nursing care hours provided per patient day		X	X		HAR FY 2012 (Inpatient and Outpatient) MHA Staffing Reports 1st QRT 2014
Restraint prevalence		X			
Smoking cessation counseling		X			
Nurse staff satisfaction			X		
Patient satisfaction with specific elements of care			X		HCAHPS
Nurse staff satisfaction			X		

Note: AHRQ is the US Agency for Healthcare Quality and Research. PSI is AHRQ Patient Safety Indicator. NQF is the National Quality Forum. ANA is the American Nurses Association and NQI is Nurse Quality Indicators. MHA is the Minnesota Hospital Association. MNHDD is Minnesota Hospital Discharge Data. HAE is Minnesota Hospital Adverse Health Events. FY is Fiscal Year (starting in October). HAR is the Minnesota Hospital Annual Report. Minnesota hospitals may report the HAR based on a fiscal year that is either during a period from January – December or any other time period. ICU is intensive care unit.

Adapted from Savitz et al., Quality indicators sensitive to nurse staffing in acute care settings. In: Hendrickson K, Battles JB, Marks ES, et al, eds. Advances in Patient Safety: From Research to Implementation. Rockville, MD: Agency for Healthcare Research and Quality; 2005:375–385

Appendix E

Literature Review

Systematic Literature Reviews (annotated bibliography)

There are four systematic reviews that were found to provide good quality assessment on the literature regarding hospital nurse staffing and patient outcomes.

Griffiths P, Ball J, Drennan J, et al. (2014). The Association between Patient Safety Outcomes and Nurse/Healthcare Assistant Skill Mix and Staffing Levels & Factors that may Influence Staffing Requirements. University of South Hampton.

Reviewers from the University of South Hampton in the United Kingdom were tasked by the National Institute of Clinical Effectiveness to determine which patient safety outcomes are associated with nurse and health care assistant staffing levels and skill mix in medical-surgical units of acute care hospitals as well as other questions outside of the scope of this study. Screening 12,146 studies resulted in 35 eligible studies meeting inclusionary and exclusionary criteria and these studies were evaluated according to quality ratings. The strongest evidence came from two studies that investigated low nurse staffing and subsequent mortality, falls and drug administration errors. Other patient outcomes such as hospital acquired infections and pressure ulcers have evidence supporting and not supporting an association with nurse staffing levels.

Kane RL, Shamliyan T, Mueller C, et al. (2007). Nurse Staffing and Quality of Patient Care. Minneapolis: Prepared by Minnesota Evidence-based Practice Center for the Agency for Healthcare Research and Quality under Contract No. 290-02-0009; Evidence Report/Technology Assessment No. 151, AHRQ Publication No. 07-E005.

Reviewers at the University of Minnesota examined the association between RN staffing and patient outcomes in acute care hospitals. Of 2,858 studies, 101 were eligible for review and 96 were included in the meta-analysis. Twenty-eight studies provided odds ratios and pooled data from these were assessed finding that hospital related mortality was associated with RN staffing levels in intensive care units as well as medical and surgical patients. Increasing RN staff by one nurse was associated with lower odds of hospital acquired pneumonia, unplanned extubation, respiratory failure, and cardiac arrest. Similarly increasing RN staff was associated with lower odds of failure to rescue and shorter lengths of stay. Surgical patients also were shown to have shorter lengths of stay.

Penoyer, DA. (2010). Nurse Staffing and Patient Outcomes in Critical Care: A Concise Review. *Critical Care Medicine;* 38(7), 1521-1528.

A reviewer identified 26 publications from 236 relevant studies to evaluate the association of nurse staffing with patient outcomes in the critical care setting such as the intensive care unit. Most studies suggested that lower nurse staffing is associated with patient outcomes such as hospital acquired infections, postoperative complications, and unplanned extubation. Many studies suggested that mortality was associated with lower nurse staffing levels, yet some studies did not find a statistical significant association between staffing and mortality.

Shekelle, PG. (2013). Nurse–Patient Ratios as a Patient Safety Strategy. A Systematic Review. Annals of Internal Medicine, 158, 404-409.

A reviewer from the RAND Corporation systematically reviewed the association between nurse staffing levels and in-hospital death. The search yielded 550 titles and 87 articles were reviewed including 15 studies that had not previously been included in systematic reviews. The same study noted by Griffiths et al., 2014 and the meta-analysis completed by Kane et al., 2007 were identified as the strongest evidence proving an association between nurse staffing and mortality. The review goes on to note that no serious harms are associated with increasing nurse staffing, but there is also a lack of evidence on the intentional increase to improve patient outcomes. Certain patient outcomes thought to be associated with nurse staffing levels did not have uniform supporting evidence including falls, pressure ulcers, and urinary tract infections.

Updated Search

Searching the literature using the PubMed database under the provided the following results: "nursing staff, hospital" provided 217 titles; "patient outcomes assessment" provided 167 titles; and "nursing staff, hospital AND patient outcomes assessment" provided three titles with only one germane to the study. This study was excluded because it investigated only the proportion of nurses with baccalaureate degrees and lower rates of postsurgical mortality and not overall staffing levels. The search string "hospital nurse staffing AND patient outcomes" yielded 14 titles.

Abstracts from these 15 studies were screened and included if it was a primary research study conducted in the United States and published in a peer-reviewed journal on the association between nurse staffing and patient outcomes. Articles were excluded if the setting did not include general care services, had measurement variables at the hospital level, and did not distinguished between nurse staffing skill mix levels.

Included Studies

Bae SH, Kelly M, Brewer CS, Spencer A. (Oct.-Dec. 2014). Analysis of Nurse Staffing and Patient Outcomes using Comprehensive Nurse Staffing Characteristics in Acute Care Nursing Units. *Journal of Nursing Care Quality;* 29(4)318-26.

Checkley W, Martin GS, Brown SM, Chang SY, et al. (Feb. 2014). Structure, Process, and Annual ICU Mortality Across 69 Centers: United States Critical Illness and Injury Trials Group Critical Illness Outcomes Study. *Critical Care Medicine*; 42(2):344-56.

Choi J and Staggs VS. (Oct. 2014). Comparability of Nurse Staffing Measures in Examining the Relationship Between RN Staffing and Unit-Acquired Pressure Ulcers: A Unit-Level Descriptive Correlational Study. *International Journal of Nursing Studies*; 51(10)1344-52.

de Cordova PB, Phibbs CS, Schmitt SK, Stone PW. (April 2014). Night and day in the VA: associations between night shift staffing, nurse workforce characteristics, and length of stay. *Research in Nursing and Health*; 37(2):90-97.

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Talsma A, Jones K, Guo Y, Wilson D, Campbell DA. (Sep. 2014). The Relationship Between Nurse Staffing and Failure to Rescue: Where Does It Matter Most? *Journal of Patient Safety;* 10(3)133-9.

Excluded Studies (International Setting)

Pitkäaho T, Partanen P, Miettinen M, Vehviläinen-Julkunen K. (Oct. 2014). Non-linear Relationships Between Nurse Staffing and Patients' Length of Stay in Acute Care Units: Baeysian Dependence Modelling. *Journal of Advanced Nursing;* online version ahead of print.

Cho E, Sloane DM, Kim EY, Kim S, Choi M, Yoo IY, Lee HS, Aiken LH. (Aug. 2014). Effects of Nurse Staffing, Work Environments, and Education on Patient Mortality: An Observational Study. *International Journal of Nursing Studies*; online version ahead of print.

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West E, Barron DN, Harrison D, Rafferty AM, Rowan K, Sanderson C. (May 2014). Nurse Staffing, Medical Staffing and Mortality in Intensive Care: An Observational Study. *International Journal of Nursing Studies;* 51(5):781-94.

Excluded Studies (Non-General Care Relevant Patient Outcomes or Non-segmentation of Nursing Staff)

Checkley W, Martin GS, Brown SM, Chang SY, et al. (Feb. 2014). Structure, Process, and Annual ICU Mortality Across 69 Centers: United States Critical Illness and Injury Trials Group Critical Illness Outcomes Study. *Critical Care Medicine*; 42(2):344-56.

Clark SL, Saade GA, Meyers JA, Frye DR, Perlin JB. (Feb. 2014). The Clinical and Economic Impact of Nurse to Patient Staffing Ratios in Women Receiving Intrapartum Oxytocin. *American Journal of Perinatology*; 31(2):119-24.

McHugh MD and Ma C. (Aug. 2014). Wage, Work Environment, and Staffing: Effects on Nurse Outcomes. *Policy Politics Nursing Practice;* online version 1-9.

Shindul-Rothschild J and Gregas M. (Aug.-Nov. 2014). Patient Turnover and Nursing Employment in Massachusetts Hospitals Before and After Health Insurance Reform: Implications for the Patient Projection and Affordable Care Act. *Policy Politics Nursing Practice;* 14(3-4):151-62.

Serratt T, Meyer S, and Chapman SA. (May 2014). Enforcement of Hospital Nurse Staffing Regulations Across the United States: Progress or Stalemate? *Policy Politics Nursing Practice;* 15(1-2):21-29.

Table E.1: Updated Literature Review Table

Author, Month, Year	Bae et al., (Oct.-Dec. 2014)	Choi and Staggs, (Feb. 2014)	de Cordova et al., (Apr. 2014)	Park et al., (Aug. 2014)	Staggs and Dunton, (Oct. 2014)	Talsma et al., (Sep., 2014)
Study Aim	To analyze nurse staffing and patient outcomes while using comprehensive nurse staffing characteristics in acute care nursing units.	To examine correlations among six staffing measures to compare explanatory power in relation to unit-acquired pressure ulcers (UAPU).	To examine the association between night nurse staffing and workforce characteristics and the length of stay (LOS).	To examine the concurrent and lagged effects of RN turnover and staffing on UAPU.	To understand how unassisted fall rates are associated with RN and non-RN staffing.	The relationship between nurse staffing and failure to rescue: where does it matter most?
Patient Outcomes Results	Rates of patient falls and injury falls were found to be greater with higher temporary RN staffing levels but decreased with greater levels of LPN hours per patient day (HPPD). Pressure ulcers were not related to any staffing characteristics.	RN-perceived staffing adequacy, RN skill mix, and unit tenure were significantly associated with UAPU.	Higher nurse staffing and a higher skill mix were associated with reduced LOS.	Higher RN staffing was associated with lower pressure ulcer rates.	Higher levels of non-RN staffing were generally associated with higher fall rates. Associations for RN staffing rates and fall rates varied by unit type.	Increased nurse staffing did not have a significant association to failure to rescue.
Study Design	Descriptive, cross-sectional correlational study	Descriptive, cross-sectional correlational study	Longitudinal retrospective study	Longitudinal retrospective study	Descriptive, cross-sectional correlational study	Descriptive, cross-sectional correlational study
Hospital setting	Intensive care units, step-down units, medical/surgical units, and other units.	Five unit types: critical care, step-down, medical, surgical, & combined medical-surgical units	Medical, medical-surgical, surgical, step-down, and telemetry units.	Four unit types: Step-down, medical, surgical, and combined medical-surgical	Five unit types: step-down, medical, medical-surgical, surgical, and rehabilitation	General care and intensive care units

	Bae et al., (Oct.-Dec. 2014)	Choi and Staggs, (Feb. 2014)	de Cordova et al., (Apr. 2014)	Park et al., (Aug. 2014)	Staggs and Dunton, (Oct. 2014)	Talsma et al., (Sep., 2014)
Author, Month, Year						
Source Population	New York hospitals.	US hospitals contributing to the 2011 NDNQI surveys and database	Veteran's Affairs (VA) hospitals from 2002 through 2006.	US hospitals contributing to the 2008-11 NDNQI surveys and database	US hospitals contributing to the 2011 NDNQI surveys and database	Patient level analysis from 6 hospitals ranging from 68 to 880 beds.
Selection Procedure	Convenience sample of 35 units within three hospitals	Convenience sample of units and nurses participating in NDNQI data collection	Convenience sample of VA hospitals.	Convenience sample of units and nurses participating in NDNQI data collection	Convenience sample of units and nurses participating in NDNQI data collection	Convenience sample of units and nurses participating in NDNQI data collection
Staffing Groups	RN, LPN, and UAP.	Total nurses (RN, LPN, and UAP), RNs alone, and non-RNs alone.	RN, LPN, and UAP.	RN, non-RN, and UAP	RNs and Non-RNs	Total nurses, RN, and RN staffing mix
Staffing Variables	Monthly and quarterly hours per patient day (HPPD).	Monthly HPPD. Six nurse staffing variables, three nurse group HPPD, RN skill mix, RN-reported number of patients, and RN-perceived staffing adequacy.	Monthly day and night shift-level HPPD.	Quarterly RN turnover, RN HPPD, Non-RN HPPD, and UAP HPPD.	RN HPPD and non-RN HPPD	Total nurse HPPD, RN HPPD, and RN staffing mix
Hospital Sample	3 hospitals	409 hospitals	138 hospitals	465 hospitals	1,361 hospitals	6 hospitals
Unit Sample	511 unit-month data points (limited to total falls) and 171 unit-quarter observations.	9,588 unit quarter observations	8,243 monthly observations.	10,935 unit quarter observations	87,544 unit quarter observations	61 general care units and 15 ICUs
Nurse and Patient Sample	Not applicable	RN survey (N=57,223),	Not applicable.	Not applicable	Not applicable	19,515 patient discharges
Outcome Measures	Total fall rates, total fall rates with injury, total pressure ulcer	Quarterly unit acquired pressure ulcer	Length of stay	Quarterly unit acquired pressure ulcer	Unassisted falls in the hospital	Failure to rescue

Author, Month, Year	Bae et al., (Oct.-Dec. 2014)	Choi and Staggs, (Feb. 2014)	de Cordova et al., (Apr. 2014)	Park et al., (Aug. 2014)	Staggs and Dunton, (Oct. 2014)	Talsma et al., (Sep., 2014)
	prevalence, and unit-acquired pressure ulcer.					
Patient Level Adjustment	None	None	Age, diagnosis-related groups, co-occurring medical conditions,	None	None	Age, sex, race, admission source, admission type, risk of mortality, and primary diagnosis group.
Nurse Level Adjustment	Skill mix—proportion of RNs to LPNs and UAP care hours, RN turnover rate, temporary nurse staff.	RN education level and unit tenure	Educational preparation, experience, and contract nurses	Nurse turnover	None	None
Hospital/ Unit Adjustment	Unit size, unit type (see above), and quality improvement initiatives.	Hospital unit types, size, teaching status, and Magnet ™ hospital status	Number of admissions	Hospital unit type, size, Medicare Case Mix Index (CMI), teaching status, and Magnet ™	Hospital bed size and teaching status	Case mix and severity of illness adjustments.
Internal Validity[22]	Moderate—the study used a number of potentially confounding factors including nurse skill mix, nurse turnover, temporary nursing staff, unit types and size, and quality improvement initiatives. There were	Low—No adjustment for patient level risk factors. Monthly staffing was linked to quarterly outcomes measures possibly reducing variability.	Moderate—study acknowledges that study would be stronger if conducted on patient-level data instead of a hospital unit-level analysis. It included a number of potentially confounding variables decreasing risk of	Low—Longitudinal approach in the study used a lagged-effect design to acknowledge that impact of staffing may be delayed. CMI is used to adjust for patient acuity, yet has been shown to be suboptimal nurse	Low—No adjustment for patient level risk factors, yet is was examined indirectly through analysis of higher staffing levels as a proxy for high acuity. Monthly staffing was linked to quarterly outcomes measures possibly	Moderate—patient outcomes events were matched with unit-specific staffing levels for that particular month. A patient clustering dynamic within units was also taken into account. Other steps were taken to include

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[22] How well did the study adjust for potential confounding factors?

Author, Month, Year	Bae et al., (Oct.-Dec. 2014)	Choi and Staggs, (Feb. 2014)	de Cordova et al., (Apr. 2014)	Park et al., (Aug. 2014)	Staggs and Dunton, (Oct. 2014)	Talsma et al., (Sep., 2014)
	no patient level adjustments to account for patient risk of falling or acquiring a pressure ulcer.		bias.	intensity metric. Monthly staffing was linked to quarterly outcomes measures possibly reducing variability.	reducing variability.	both patient and clinical risk adjustment. No additional hospital or nurse factors were included.
External Validity[23]	Moderate—the study noted a lack of general applicability to other regions.	Moderate—hospitals and nurses may self-select regarding data participation.	Low—the findings are only relevant to VA hospitals.	Moderate—hospitals may self-select regarding data participation.	Moderate—hospitals may self-select regarding data participation.	High—ample descriptions of study.

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[23] Are there enough details provided to make the findings applicable to the general population?

Table E.2: Published Evidence on Association of Low Nurse Staffing and Patient Outcomes

Patient Outcome	Strong Evidence of Positive Association	Strong Evidence of Negative Association	Studies with Granular Time Units[1]	Moderate to Weak Evidence of Positive Association	Moderate to Weak Evidence of Negative Association
Mortality	Yes	No	Needleman et al. 2011	No	No
Failure to Rescue	Yes	No	Kutney-Lee et al., 2013 & Talsma et al., 2014	No	No
Falls in the Hospital	Yes	No	Donaldson et al., 2005 & Patrician et al., 2011	Yes	No
Pressure Ulcers	Yes	Yes	Donaldson et al., 2005	Yes	No
Hospital Acquired Infections					
Pneumonia	No	No	--	Yes	Yes
Surgical Site Infection/Sepsis	No	No	--	Yes	No
Select Infections Due to Medical Care	No	No	--	Yes	No
Urinary Tract Infection	No	No	--	No	No
Venous Thromboemolism	No	No	--	No	No
Patient Satisfaction	No	No	--	No	No
Drug Administration Errors	Yes	No	Patrician et al., 2011	Yes	Yes
Length of Stay	Yes	No	de Cordova et al. 2014	Yes	No
Missed Nursing Care	Yes	No	Tschannen et al., 2010	Yes	No
Readmissions	No	No	--	Yes	No

Adapted from Griffiths et al., 2014 (limited to US studies) and updated search from Feb.-Oct. 2014.

[1] Granular time units are daily or monthly nurse staffing and outcomes measures.

Appendix F

Data Request Letter to Hospital Administrators

MINNESOTA MDH DEPARTMENT OF HEALTH

Protecting, maintaining and improving the health of all Minnesotans

July 23, 2014

Hospital Administrator Name
Title, Hospital Name
Hospital Address
City, State Zip

Dear Hospital Administrator:

During the 2013 Regular Session, the Minnesota Legislature passed Minnesota Law Chapter 51—HF588, directing the Department of Health (MDH) to conduct a study of the correlation between nurse staffing levels and patient outcomes at Minnesota hospitals. The assignment from the Legislature to conduct a study came with the clear responsibility that MDH produce robust analytic work that would allow the Legislature to move beyond anecdotes to a deeper understanding of the relationship between these issues. Given that charge from the Legislature, MDH is collecting data from hospitals that are essential to analyze how potential variability in nurse staffing relates to standard nurse-sensitive patient outcome metrics from the same time period. These data are more granular than data submitted under the Staffing Plan Disclosure Act and cover a time period that coincides with available hospital claims data (2013) to allow for case-mix adjustment.

With this letter, I would like to request that you complete the enclosed data collection template and **submit the data securely to MDH by September 1, 2014**. The template will also be shared with you electronically to ease submission of the data via MDH's secure web application at: https://apps.health.state.mn.us/mdh_upload/. You may also obtain the template as well as review other information regarding the study at the following web address: http://www.health.state.mn.us/divs/hpsc/hep/nursestudy/index.html.

Identical data will be collected from 39 other community hospitals that are characterized by an average daily census of greater than 20 patients and occupancy rate higher than 20 percent. As indicated in the enclosed instructions, please provide the file to the attention of Nathan Hierlmaier at Nathan.hierlmaier@state.mn.us.

Before making this request, MDH convened a workgroup to consult in conceiving the study. MDH also had the opportunity to connect with representatives of the Minnesota Hospital Association, who urged the Department to carefully consider the importance of its request, given the resulting reporting burden and the remaining likely limitations associated with the study.

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Administrator Name
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July 23, 2014

Also enclosed is a document that provides answers to questions you may have in the context of this request. In addition, if hospitals would find it of use, MDH could convene a webinar at which to discuss the request and any associated questions. Please communicate your interest in a webinar and direct any immediate questions to Stefan Gildemeister, Director of the Department's Health Economics Program. He can be reached by phone at 651-201-3554 or by email at stefan.gildemeister@state.mn.us.

Sincerely,

James G. Koppel
Deputy Commissioner
P.O. Box 64975St. Paul, MN 55164-0975

Enclosure: Data collection template and Frequently Asked Questions