Effects of Nurse Staffing on Processes of Care and Resident Outcomes in Nursing Homes: A Systematic Review

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PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted health care topics of importance to clinicians, managers, and policymakers as they work to improve the health and health care of Veterans. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The program comprises four ESP Centers across the US and a Coordinating Center located in Portland, Oregon. Center Directors are VA clinicians and recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Center Program. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, interface with stakeholders, and address urgent evidence needs. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee composed of health system leadership and researchers. The program solicits nominations for review topics several times a year via the program website.

The present report was developed in response to a request from the Office of Nursing Services. The scope was further developed with input from Operational Partners (below), the ESP Coordinating Center, the review team, and the technical expert panel (TEP). The ESP consulted several technical and content experts in designing the research questions and review methodology. In seeking broad expertise and perspectives, divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Ultimately, however, research questions, design, methodologic approaches, and/or conclusions of the review may not necessarily represent the views of individual technical and content experts.

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Operational Partners

Operational partners are system-level stakeholders who help ensure relevance of the review topic to the VA, contribute to the development of and approve final project scope and timeframe for completion, provide feedback on the draft report, and provide consultation on strategies for dissemination of the report to the field and relevant groups.

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To ensure robust, scientifically relevant work, the TEP guides topic refinement; provides input on key questions and eligibility criteria, advising on substantive issues or possibly overlooked areas of research; assures VA relevance; and provides feedback on work in progress. TEP members are listed below:

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The Coordinating Center sought input from external peer reviewers to review the draft report and provide feedback on the objectives, scope, methods used, perception of bias, and omitted evidence (see Appendix E for disposition of comments). Peer reviewers must disclose any relevant financial or non-financial conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The Coordinating Center works to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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ABBREVIATIONS TABLE

Abbreviation	Definition
ADL	Activities of daily living
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CLC	Community Living Center
COE	Certainty of Evidence
CMS	Centers for Medicare and Medicaid Services
ESP	Evidence Synthesis Program
HPRD	Hours per resident day
KQ	Key question
LPN	Licensed practice/vocational nurse
MDS	Minimum Data Set
MeSH	Medical subject heading
NA	Nursing assistant
NH	Nursing home
NHC	Nursing Home Compare
NORS	National Outbreak Reporting System
NR	Not reported
OR	Odds ratio
PAH	Potentially avoidable hospitalizations
RN	Registered nurse
TEP	Technical expert panel
US	United States
UTI	Urinary tract infection
VHA	Veterans Health Administration

EVIDENCE REPORT

INTRODUCTION

PURPOSE

The VA Evidence Synthesis Program (ESP) was asked by the VA Office of Nursing Services, in collaboration with Geriatrics and Extended Care, for an evidence review on the effects of nurse staffing levels and skill mix on quality of care and resident outcomes in nursing homes. Findings from this review will be used to guide the development of nurse staffing recommendations for VA nursing homes, as well as to inform VA guidance for State Veterans Homes.

BACKGROUND

In the United States (US), 1.3 million people reside in more than 15,000 nursing homes.[2,3] Nursing homes are complex environments with heterogenous populations needing rehabilitative post-acute, end-of-life, or custodial long-term care. Nursing home residents have diverse care needs and diagnoses that vary within and across facilities.[4] Nursing homes may be stand-alone facilities (independently owned or part of a network of facilities) or part of integrated care networks that include hospitals and clinics or continuing care communities that include independent and assisted living units.[5] Within nursing homes, direct care nursing staff (*ie*, registered nurses [RN], licensed vocational or practical nurses [LPN], and nursing assistants [NA]) are the primary caregivers for residents[6]; thus, the level and characteristics of nursing staff are likely to impact resident well-being, health, safety, and quality of life.

US nursing homes are governed by complex regulatory and payment policies.[7] States license nursing homes to operate, and the Centers for Medicare and Medicaid Services (CMS) certifies facilities to receive Medicare and/or Medicaid payments. Almost all US nursing homes are CMS certified. Although the Institute of Medicine recommends that nursing homes have at least 1 RN on duty 24 hours a day,[7,8] federal and state regulations do not currently require this level of nurse staffing.[9] Federal regulations only require having at least 1 RN on duty 8 hours a day, and that nursing homes have sufficient staff to provide nursing care to all residents (Nursing Home Reform Act 1987).[10] States can impose more stringent regulations but none currently require that nursing homes have an RN on duty 24 hours per day. State regulations typically require a specific number of nursing hours per resident per day (HPRD). For example, California currently requires a minimum of 3.5 HPRD of direct nurse staffing.[11,12] As part of the Nursing Home Compare 5-Star Rating System, CMS calculates expected staffing levels based on resident acuity; CMS estimates that the average US nursing home should have 4.2 hours of nursing HPRD.[6] However, most nursing homes have staffing levels below this.[6,13] There are also large daily variations in staffing levels within certain facilities, and some evidence that facilities may increase staffing to coincide with annual inspections.[13]

The Department of Veterans Affairs (VA) operates 134 nursing homes, called Community Living Centers (CLCs), that together currently provide a total of 8,480 beds.[1] CLCs are often attached to VA medical centers or hospitals, but may also be stand-alone facilities.[14] Due to VA nurse staffing requirements, CLCs have higher levels of nurse staffing than non-VA community nursing homes. CLCs serve a variety of resident populations, which may on average have higher acuity and complexity of needs than residents in most non-VA community nursing homes.[15]

There is also a set of State Veterans Homes that are independently run by state governments. These State Veterans Homes must meet federal and state regulations for nursing homes, but do not have to adhere to the same VA nurse staffing requirements as CLCs. VA has responsibility for certifying that State Veterans Homes meet certain standards and conducts annual surveys to make these determinations.

Although some studies have indicated that higher nurse staffing levels lead to better resident outcomes,[16-18] it remains unclear how overall nurse staffing levels and skill mix can be optimized to achieve improvements in process of care (*eg*, limited use of antipsychotics) and resident outcomes (*eg*, decreased pressure ulcers and pain), particularly in the setting of constraints due to cost and nursing workforce availability.

We conducted a systematic review on the effects of nurse staffing levels and staff mix on processes of care and resident outcomes in nursing homes. In this report, we summarize the evidence on effects of nurse staffing levels and skill mix on a variety of outcomes, beginning with those selected as high priority: pressure ulcers, nursing home-associated infections, and pain outcomes. For these high-priority outcomes, we also provide certainty of evidence for the summary findings. We then describe results for additional outcomes, including urinary catheters, functioning, quality of life, and hospitalizations, among others. Finally, we discuss implications of these results for VA policy and recommendations for future research.

METHODS

TOPIC DEVELOPMENT

We worked with our representatives from the VA Office of Nursing Services and our Technical Expert Panel (TEP) to refine the review scope and develop the key questions (KQ). We developed a conceptual framework based on the Donabedian model for evaluating outcomes and quality of care provided by healthcare systems and facilities.[19] The Donabedian model consists of 3 connected components: 1) Structure as organizational characteristics associated with the delivery of care (*eg*, number of nurses); 2) processes of care are what happens for the patient or resident (*eg*, prescribed antibiotics); and 3) outcomes measures that capture the effect of care on patient health or other metrics that are meaningful to the patient. In this review, we conceptualized that the structure of care in nursing homes includes nurse staffing levels and skill mix as important characteristics; these in turn impact processes of care (*eg*, use of antipsychotic medications and urinary catheters), which then impact resident outcomes (*eg*, nursing home-associated infections, pain severity, and quality of life) (Figure 1). We also considered that resident characteristics are likely to impact both processes of care and resident outcomes. Nurse staffing levels include care provided by different types of nursing staff (Table 1), as well as total care provided by all nursing staff. Nurse skill mix refers to the proportions or ratios between different types of nurses (*eg*, RN to total staffing).

Figure 1. Conceptual Framework

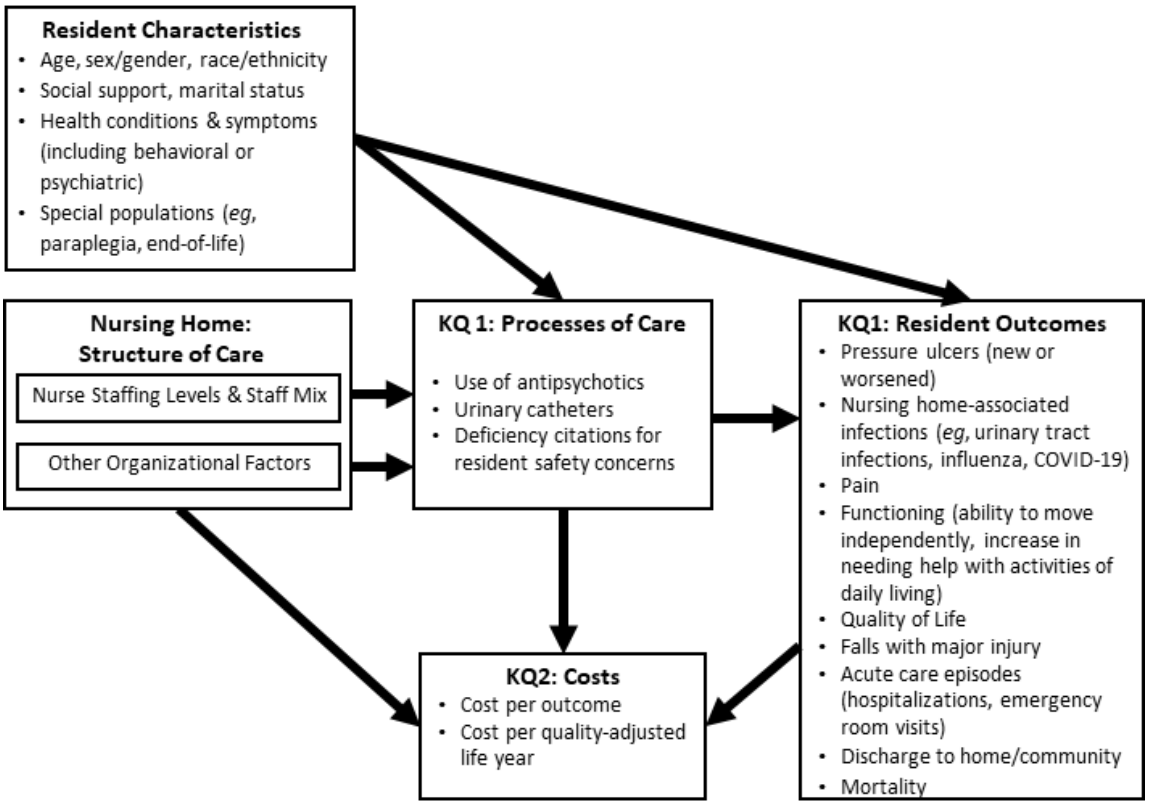


Table 1. Nursing Staff Characteristics and Responsibilities

Nursing Title	Education & Training Requirements	Responsibilities
Nursing Assistants (NA)	• May need to complete a state-approved education program and pass their states' competency exam to become licensed or certified	• Provide basic care • Help patients with activities of daily living
Licensed Practical or Vocational Nurses (LPN)	• Must complete a state-approved educational program, which typically takes about 1 year • Must be licensed	• Provide basic nursing care
Registered Nurse (RN)	• May take different educational paths, such as bachelor's degree in nursing, or associate's degree in nursing with additional training • Must be licensed	• Provide and coordinate patient care

*source: https://www.bls.gov/ooh/healthcare/home.htm

KEY QUESTIONS (KQ)

KQ1: What are the effects of nursing home nurse staffing levels and staff mix on:
a) Processes of care in nursing homes (*eg*, use of antipsychotics)?
b) Resident outcomes in nursing homes (*eg*, falls)?

KQ2: Which nurse staffing levels and staff mix have demonstrated cost-effectiveness for improving resident outcomes?

PROTOCOL

A preregistered protocol for this review can be found on the PROSPERO international prospective register of systematic reviews (http://www.crd.york.ac.uk/PROSPERO/; registration number CRD42021266319.

DATA SOURCES AND SEARCHES

We searched for peer-reviewed English-language articles from January 2000 to May 2021 in the following databases: MEDLINE, Embase, CINAHL, and the Cochrane Database of Systematic Reviews. We used Medical Subject Headings (MeSH) and title/abstract terms for nurse staffing (Table 1) and nursing homes (Appendix A). We also hand-searched bibliographies of relevant systematic reviews, identified from searches of the above databases, VA ESP, and AHRQ Evidence-based Practice Centers.

To supplement findings from the peer-reviewed literature, we also conducted a search of the grey literature. We developed a list of websites with input from our TEP and used key words to search these websites for relevant white papers pertaining to effects of nurse staffing on processes of care and resident outcomes in nursing homes. Websites searched included those for federal government agencies (*eg,* CMS, Centers for Disease Control and Prevention [CDC]), and professional organizations (*eg*, American Nurses Association); the full list of websites is provided in Appendix A. One reviewer conducted searches of websites and compiled a list of

records for potentially relevant documents; these records were then screened by another reviewer to assess relevance and possible inclusion in the review. Documents included by the second reviewer were pulled and examined by a third reviewer for final determination of inclusion.

STUDY SELECTION

After removal of duplicates and conference abstracts, citations were uploaded into DistillerSR (Evidence Partners, Ottawa, Canada). Using prespecified inclusion and exclusion criteria (Table 2), titles and abstracts were screened by 2 reviewers. Articles included by either reviewer underwent full-text review. At full-text review, 2 individuals decided on inclusion/exclusion by consensus (input from a third reviewer was requested as needed). A list of studies excluded at full-text review is provided in Appendix B.

Eligible populations were adults (≥ 18 years of age) living in US nursing homes. Studies were excluded if evaluating other types of congregant settings (*eg*, homes for those with developmental disabilities or transitional housing for addiction treatment). Eligible articles addressed the effects of nurse staffing levels (*eg*, nurse hours per patient) or skill mix (*eg*, ratio of RN to total nursing staff) on processes of care (*eg*, receipt of antipsychotics and receipt or duration of urinary catheter) and/or resident outcomes (*eg,* pressure ulcers, nursing home-associated infections, and pain).

Table 2. Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Population	18 years or older residents of nursing homes	< 18 years of age; living in group homes for mental health or developmental disabilities, or transitional housing for addiction recovery, *etc*
Intervention	Staffing levels and staff mix: RN, LPN, NA (*eg*, nurse hours per resident, nurse to resident ratios, RN to total nurse staffing ratios)	Non-nurse disciplines
Comparator	Any	
Outcomes	• Process Outcomes – Receipt of antipsychotic, antianxiety, or hypnotic medication – Receipt and/or duration of urinary catheter – Deficiency citations for resident safety or quality of care • Resident Outcomes – Nursing home-associated infections (*eg,* urinary tract infection, influenza, pneumonia, COVID-19) – Pressure ulcers (new or worsened) – Falls with major injury – Acute care episodes (hospitalizations, emergency room visits) – Discharge to home or community	

	– Functioning (ability to move independently, increase in needing help with activities of daily living) – Pain severity – Quality of life – Mortality • Cost Effectiveness – Cost per outcome Cost per quality-adjusted life year	
Timing	Any	
Setting	United States nursing homes (includes Community Living Centers and State Veterans Homes)	Assisted living facilities, facilities exclusively focused on acute care settings (*ie*, emergency rooms and inpatient floors) or congregant settings that are not providing skilled nursing services (*ie* prison, *etc*)
Study Design	Randomized controlled trials or observational studies	Reviews, study protocols, case studies, editorials, qualitative, no comparison group

DATA ABSTRACTION AND QUALITY ASSESSMENT

Study quality was independently assessed by 2 reviewers using a modified version of the Joanna Briggs Institute Critical Appraisal Tool Checklist for Analytical Cross-Sectional Studies (Appendix C).[20] The original tool included 8 domains: inclusion criteria, study subject and setting description, exposure measurement, identification of confounders, strategies to deal with confounders, outcome measurement, and statistical analysis. To make these criteria more applicable for longitudinal observational studies, we added 2 domains: whether the explanatory variable preceded assessment of outcomes of interest, and whether follow up was complete and adequately described. Generally, a study rated as having methodological concerns in 2 or more domains was considered low quality overall. If needed, a third reviewer also evaluated the study to help reach consensus on the quality rating. Ratings for eligible studies can be found in Appendix D.

Abstracted data from all eligible studies included the following: study design, setting and population characteristics, data sources, definitions of nurse staffing and/or skill mix, and processes of care or resident outcomes evaluated. For studies rated as moderate or high quality, we also abstracted detailed results on characteristics of staffing (amount and different types of nurse staffing, including total staffing [RN, LPN, and NA]); effects or associations between nurse staffing (or skill mix) and processes of care or resident outcomes; and detailed analytic methods (*eg*, consideration of confounders and analytic models). We categorized data sources into 5 large categories (Table 3). We also noted if study outcomes were attributed separately for VA vs non-VA facilities, or if the study primarily involved VA facilities. Data were abstracted by 1 person and over-read by second. If needed to resolve conflicts, a third reviewer also evaluated the study.

Table 3. Data Sources

Category	Data Sources
CMS	Minimum Data Set (MDS)
	Online Survey Certification and Reporting (OSCAR)
	Certification and Survey Provider Enhanced Reporting (CASPER)
	CMS National Health Safety Network Public File
	Nursing Home Compare Archives (NHC)
	Payroll Based Journal
	Provider of Service
	Medicare & Medicaid claims data
	Medicare Healthcare Cost Report Information System (HCRIS)
Other Federal	LTCFocus (https://ltcfocus.org/)
	National Nursing Home Survey (CDC)
	Census
	Area Health Resource File
State Agencies	State Agency Data
	California Cost Report
Infectious Disease	Hopkins COVID-19 Dashboard
	National Outbreak Reporting System (NORS)
	COVID-19 Nursing Home Dataset
Other	Company or corporation data
	News organizations
	American Hospital Association Database
	Surveys (independent study)
	Direct observation or time study

SYNTHESIS & CERTAINTY OF EVIDENCE

Due to heterogeneity in populations, methods, and outcomes of included studies, we performed qualitative synthesis of the results. We summarized key study findings categorized by the processes of care and/or resident outcomes being evaluated. For the 3 high-priority outcomes (pressure ulcers, nursing home-associated infections, and pain), we also rated overall certainty of evidence using a GRADE approach.[21-23] Briefly, for each outcome and nurse staffing variable, we evaluated characteristics of the evidence across 5 domains: methodological limitations, imprecision, inconsistency, indirectness, and publication bias. For methodological limitations, we considered factors such as accuracy of data assessment (for both outcomes and nurse staffing), timing of outcomes with respect to nurse staffing data, and use of appropriate analytical models. To evaluate indirectness, we examined how applicable the results were to our key questions, including population characteristics and type of outcomes assessed. For imprecision, we considered the number of events, sample size, and precision of effect estimates reported by included studies. Inconsistency relates to whether the direction and magnitude of effects are similar (or different) across the included studies. Finally, we considered the role of publication bias, which may lead to preferential reporting of positive results (particularly from small studies

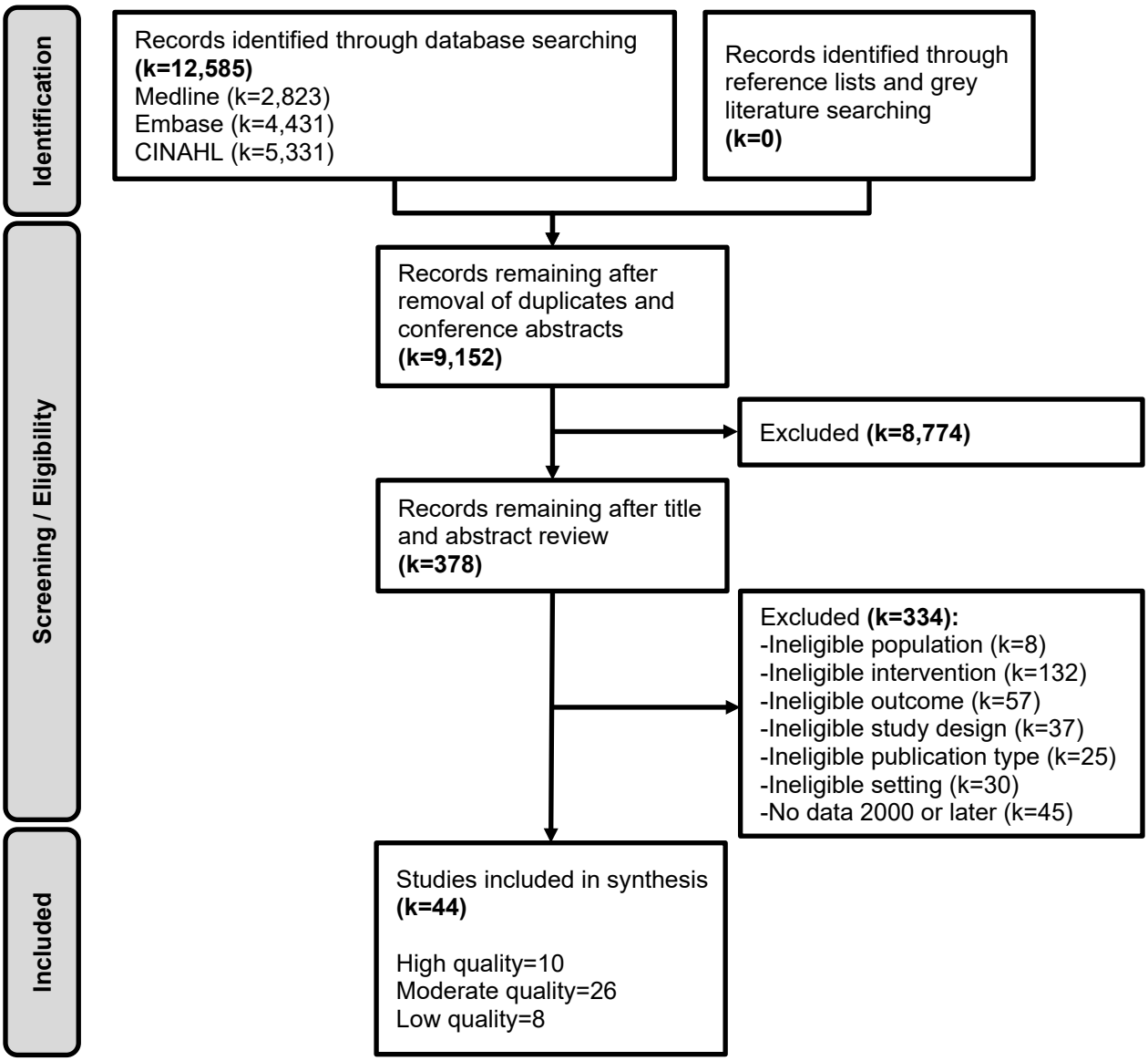
or those looking at many different outcomes). The overall certainty of evidence takes into consideration individual ratings in each of these 5 domains, but domains may not be weighted equally in determining the overall rating.

RESULTS

OVERVIEW OF ELIGIBLE STUDIES

Of 9,152 unique titles and abstracts screened, 378 articles underwent full-text review (Figure 2). We identified 44 eligible studies after full-text review. A list of studies excluded at full-text review is provided in Appendix B. We also searched 14 websites for grey literature and identified 62 documents for potential inclusion. However, none were found to be eligible after evaluation by 2 reviewers. Most of these documents did not report new data on nurse staffing or resident outcomes; the few that provided data on these topics did not conduct analyses to examine the relationship between nurse staffing and outcomes.

Figure 2. Screening and Selection of Eligible Studies



The most commonly evaluated outcomes were pressure ulcers (k=15),[18,24-36] nursing home-associated infections (k=13),[11,18,28,29,33,35,37-41] hospitalizations (k=8),[24,37,42-47] residents with moderate to severe pain (k=7),[25,26,29,31,33,35,36] and urinary catheters (k=7)[26,28,29,31,33,35,36] (Table 4). Fourteen eligible studies addressed multiple processes of care or resident outcomes of interest.[18,24-26,28,29,31,33-37,40,42] None of the eligible studies addressed cost effectiveness (KQ2). Most studies used national US samples of nursing homes (k=21) and were cross-sectional (k=24). Only 1 study addressed nurse staffing and resident outcomes in VA CLCs.[40] Ten included studies were high quality, 26 were moderate quality, and the remaining 8 were low quality (Table 4). Methodological concerns across many studies included: accuracy of outcomes and staffing data (most were reported by nursing home staff or administrators); timing of outcomes assessment with respect to staffing measures (*eg*, outcomes may have been assessed before data collection on staffing levels); and adequate consideration of confounders. From high- and moderate-quality studies, we abstracted detailed results on associations between nurse staffing and processes of care or resident outcomes. Detailed study characteristics and results for these studies are found in Appendix F.

First, we present results for key outcomes that were both high priority for our stakeholders and addressed by a sufficient number of studies: pressure ulcers, nursing home-associated infections, and pain (moderate to severe). We describe effects separately by different nurse staffing (*eg*, RN, LPN, or NA) or skill mix variables. We also present overall certainty of evidence for summary findings regarding these outcomes (using GRADE, see Methods). Then, we summarize results for the remaining outcomes.

Table 4. Summary Characteristics of Eligible Studies

Characteristics	# Studies by Quality		
	High (k=10)	**Moderate** (k=26)	**Low** (k=8)
Study Design			
Cross-sectional	4	16	4
Longitudinal	5	8	4
Repeated time series	1	2	—
Data Sources			
CMS	10	25	6
VA	1	—	—
Other federal sources	1	7	2
State agencies	3	14	—
Infectious disease datasets	2	1	—
Other*	4	15	3
Settings			
National US	4	15	2
State-level:			
≥10 States	2	—	—
<10 States	4	12	6
Nurse Staffing Levels & Skill Mix			

Characteristics	# Studies by Quality		
	High (k=10)	**Moderate** (k=26)	**Low** (k=8)
Nurse staffing was primary or secondary focus of study	8	13	NA
Independent variable(s):			
Nurse staffing levels	10	27	8
Skill mix	5	9	4
Resident Outcomes & Processes of Care			
Pressure ulcers	1	11	3
Infections:			
COVID-19	3	1	—
Others†	2	4	2
Pain (moderate to severe)	—	6	1
Urinary catheters	—	7	—
Functioning	1	2	2
Quality of life	—	3	1
Hospitalizations	1	4	3
Citations for quality of care	1	5	1
Antipsychotic use	—	2	—
Falls with major injury	1	1	—
Discharge to home or community	1	—	—
Mortality (all-cause)	—	1	—

Abbreviations. CMS=Centers for Medicare & Medicaid Services; NA=not abstracted; VA=Department of Veterans Affairs
*Company or corporation data, news organizations, American Hospital Association Database, independent surveys, direct observation, or time study
†Urinary tract infections, pneumonia, and norovirus

PRESSURE ULCERS

One high-quality[18] and 11 moderate-quality studies[26-33,35,36,42] evaluated the association of pressure ulcers with nurse staffing levels (see Appendix Table F-1 for detailed results). Nine studies were cross-sectional[26,28-30,32,33,35,36,42] and 3 were longitudinal analyses.[18,27,31] Though all 12 studies used data derived from the Minimum Data Set (MDS), the outcome measures regarding pressure sores varied across studies. Pressure ulcers were primarily measured as prevalence among NH residents, but 1 study used the incidence of pressure ulcer within the past 14 days.[18] One study specifically evaluated the number of residents with dementia who died with pressure ulcers (defined as having pressure ulcers on the last MDS before death).[42] Most studies used data from years within 1999-2008. Six evaluated national samples of nursing homes, while the remaining used data from selected states. Sample sizes ranged from 63 to 14,618 nursing homes. Besides data from federal agencies and sources, 6 studies used state agency data[26-28,33,35,36] and 7 used other data sources (*eg*, American Hospital Association data, or private company data).[26,30-33,35,36] Five studies were conducted by the same research team led by Castle, GC.[26,31,33,35,36]

RN Staffing

Higher RN staffing is probably associated with fewer pressure ulcers among residents of nursing homes (moderate confidence, Table 5). Among 11 studies addressing the relationship between RN staffing and pressure ulcers, 9 found that higher RN staffing was associated with fewer pressure ulcers.[18,26-28,31,33,35,36,42] The remaining 2 studies found no association between RN staffing levels and the outcome of interest.[29,32] Eight studies included conceptual models to inform their study design. Six studies conducted analyses adjusting for case mix and all studies adjusted for confounders such as environment, policy, and other staffing metrics. Five studies were conducted by Castle et al and all included conceptual models.[26,31,33,35,36] The primary methodological limitation among all studies was uncertainty about whether measures of RN staffing had preceded assessment of the pressure ulcer outcomes. The magnitude of the association between RN staffing and pressure ulcers in nursing home residents is not clear.

LPN Staffing

Higher LPN staffing may be associated with fewer pressure ulcers (low confidence, Table 5). Five moderate- and high-quality studies evaluated associations between LPN staffing and pressure ulcers.[31-33,35,36] Four of these were from the same lead author (Castle, NG) and showed that higher LPN staffing was associated with fewer pressure ulcers.[31,33,35,36] The fifth study found no association between measures of staffing and resident outcomes.[32]

NA Staffing

Higher NA staffing may be associated with fewer pressure ulcers (low confidence, Table 5). Seven studies examined associations between NA staffing and pressure ulcers.[26,27,31-33,35,36] Four of these found that higher NA staffing was associated with a decrease in pressure ulcer presence.[26,27,31,36] The remaining 3 studies found no association between NA staffing levels and the outcome of interest.[32,33,35]

Total Staffing

Total staffing is probably not associated with pressure ulcers in nursing home residents (moderate confidence, Table 5). Two studies of moderate quality evaluated total staffing and pressure ulcers in residents.[29,30] One study was conducted in 162 facilities among high-risk patients,[30] while the second study had a population size of 1,142 and was among all residents.[29] The study by Temkin-Greener et al[30] had a conceptual model and controlled for case/resident mix and other confounders of interest. It found no association between total staffing and the likelihood of pressure ulcers in the resident population (OR 1.11, p=0.62). The study by Trinkoff et al[29] did not have a conceptual model and while it did control for other factors it did not control for case mix. As with Temkin-Greener et al, Trinkoff et al also did not find an association between total staffing and the presence of pressure ulcers (OR 1.01 [0.56, 1.82] among high-risk residents, OR 1.21 [0.58, 2.53] among low-risk residents).

Nurse Skill Mix

Higher skill mix may be associated with fewer pressure ulcers among residents (low confidence, Table 5). Six studies evaluated skill mix as ratio of RN staffing to total staffing.[18,26,29,31,36,42] Three of the studies included a conceptual model to inform their study and analytic design. Four of the studies included case mix as a confounder of interest, and all included other confounders

such as environment, policy, and other staffing metrics in the models investigating the relationship between staff/skill mix and the outcome of interest. Three studies reported no association,[18,29,42] and the other half of the studies reported an association between nurse skill mix and pressure ulcers.[26,31,36]

Table 5. Summary Findings for Pressure Ulcers in Nursing Home (NH) Residents

Staffing Measure or Skill Mix	Summary of Findings	Methodological Limitations	Indirectness	Imprecision	Inconsistency	Publication Bias	Overall Confidence
RN Staffing [18,26-29,31-33,35,36,42]	Higher RN staffing is probably associated with less pressure ulcers (rates or likelihood) among NH residents	Serious[a]	Not Serious	Not serious	Not Serious[b]	Not Suspected	Moderate
LPN Staffing [31-33,45,46]	Higher LPN staffing may be associated with less pressure ulcers (rates or likelihood) among NH residents	Serious[a]	Not Serious	Not serious	Serious[c]	Not Suspected	Low
NA Staffing [26,27,31-33,35,36]	Higher NA staffing may be associated with less pressure ulcers (rates or likelihood) among NH residents	Serious[a]	Not Serious	Not serious	Serious[d]	Not Suspected	Low
Total Staffing [29,30]	Total staffing is probably not associated with pressure ulcers among NH residents	Serious[a]	Not Serious	Not serious	Not Serious	Not Suspected	Moderate
Skill Mix [18,26,29,31,36,42]	Higher skill mix may be associated with less pressure ulcers (rates or likelihood) among NH residents	Serious[a]	Not Serious	Not serious	Serious[e]	Not Suspected	Low

Abbreviations. LPN = Licensed Practical Nurse; NA = Nursing Assistant; RN = Registered Nurse

[a] Pressure ulcers data relied on report by NH staff; most studies were cross-sectional; half or most of the results from studies conducted by the same lead author

[b] Nine of 11 studies found an association between RN staffing levels and a reduction in pressure ulcers among residents

[c] Four of the 5 studies were from the same lead author and all found an association; the 1 study not by the same author group found no association

[d] Three studies reported no association and the remaining 4 reported an association.

[e] Three studies reported no association and 3 reported an association

NURSING HOME-ASSOCIATED INFECTIONS

Ten moderate- and high-quality studies examined nursing home associated infections.[11,18,28,29,35,39-41,48,49] We first present results for COVID-19 outcomes, followed by other infections (*eg*, urinary tract infection [UTI]). See Appendix Table F-1 and Appendix Table F-2 for detailed study characteristics and results.

COVID-19 Cases and Mortality

Three high-quality studies[11,48,49] and 1 moderate-quality study[39] evaluated the association between nurse staffing and COVID-19 cases and/or mortality. One study evaluated combined resident and staff COVID-19 deaths.[49] Three studies were cross-sectional[11,39,49] and 1 used repeated time series analyses.[48] Two studies evaluated nursing homes within a single state,[11,39] while 1 study looked at nursing homes in 17 states,[48] and the fourth looked at national data.[49] All 4 studies obtained staffing data from the CMS Payroll-Based Journal (PBJ), and controlled for the facility size.[11,39,48,49] Three of these studies also accounted for the prevalence of COVID-19 in the local community.[39,48,49] COVID-19 data were obtained from a variety of federal,[48,49] state,[11,39] county,[11] and news organization sources.[11,39] Methodological concerns for all of these studies were mainly regarding accuracy of data for COVID-19 outcomes reporting, timing of nursing home staffing data versus COVID-19 outcomes, and possible staff shortages due to COVID-19 outbreaks.

Across the 4 studies, RN HPRD ranged from 0.449 to 0.75. Total staffing was evaluated in 2 studies, with mean HPRD 3.9 in one,[11] and 55% of nursing homes < 4.1 total nurse HPRD in the other.[11,49] Only 1 study examined relationships between NA staffing (mean HPRD 2.3) or LPN staffing (mean HPRD 0.9) and COVID-19.[49]

RN Staffing

Higher RN staffing may be associated with lower resident COVID-19 infection and mortality (low confidence, Table 6). Four studies investigated the relationship between RN staffing and COVID-19 cases or mortality.[11,39,48,49] The 2 state-level studies and 1 regional study all found that higher RN staffing was significantly associated with fewer COVID-19 cases and/or mortality.[11,39,48] However, 1 national study found higher RN staffing was significantly associated with higher likelihood of nursing home having any COVID-19 cases (OR 1.34, $p<0.01$).[49]

LPN Staffing

LPN staffing may not be associated with COVID-19 infection or mortality (low confidence, Table 6). A single national study examined the relationship between LPN staffing and COVID-19 outcomes.[49] It found no statistical association between LPN staffing and COVID-19 cases and low LPN staffing relative to medium LPN staffing was associated with fewer COVID-19 deaths. High LPN staffing relative to medium LPN staffing was not associated with COVID-19 mortality.

NA Staffing

Higher NA staffing may be associated with lower COVID-19 infection and mortality (low confidence, Table 6). The same national study described above also examined the relationship between NA staffing and COVID-19 outcomes.[49] It found that among nursing homes with at

least 1 COVID-19 case, those with high NA staffing (compared with middle tertile) had a lower likelihood of having an outbreak and fewer COVID-19 resident and staff deaths.

Total Staffing

It is unknown if total staffing is associated with COVID-19 infections or mortality (very low confidence, Table 6). One national study[49] and 1 state-level study[11] examined associations between total nurse staffing and COVID-19 outcomes. The national study found that nursing home with both low and high total staffing (compared to middle tertile) had fewer COVID-19 deaths. The state-level study found no association between nursing hours and COVID-19 cases.

Nurse Skill Mix

Higher nursing skill mix may be associated with higher resident COVID-19 infection (low confidence, Table 6). The same national study described above also examined the relationship between nurse skill mix COVID-19 outcomes.[49] Skill mix was measured as RN to total nurse staffing. This study found that lower staff skill mix was significantly associated with lower likelihood of having any COVID-19 cases, while higher skill mix was associated with greater likelihood. The study found no association between staff skill mix and COVID-19 mortality.

Other Infections

Six articles evaluated the association between nursing home staffing and infections.[18,28,29,35,40,41] Four studies evaluated UTI,[18,28,29,35] another study examined a composite measure of UTI, pneumonia, and pressure ulcers,[40] and the sixth study addressed increased hospitalizations and mortality during norovirus outbreaks.[41] Two of these were high quality and used longitudinal design,[18,40] while 3 moderate-quality studies were cross-sectional[28,29,35] and 1 moderate-quality study was also longitudinal.[41] Two studies used an instrumental variable approach.[18,28] One of these used the time a nursing home implemented the Medicare Prospective Payment System and percent of residents in a nursing home with Medicare as a payer source as the instrumental variables.[18] The other study used the percent of the population over age 65 and the percent of females in the workforce as instrumental variables.[28]

One study focused specifically on VA CLCs, evaluating the composite measure noted above.[40] Three studies focused on nursing homes in a single state[28] or a small number of states.[18,41] The remaining 2 studies focused on a national sample of US nursing homes.[29,35] Staffing measures were obtained from study-specific survey data,[29,35] OSCAR,[18,28] or VA payroll data.[40] Outcome data were obtained from the MDS,[18,28,29,40,41] and Nursing Home Compare.[35] Across these studies of non-VA US nursing homes, RN HPRD ranged from 0.1 to 0.6. In the VA CLC study, average total nurse staffing was 4.6 HPRD (SD 1.2), with 31% being RN, 26% LPN, and 42% NA.[40]

RN Staffing

Higher RN staffing may be associated with less UTI (proportion and likelihood) among residents (low confidence, Table 6). Three studies addressed the relationship between RN staffing and urinary tract infections.[18,28,35] One high-quality study using instrumental variable approach found greater RN staffing was significantly associated with lower UTI.[18] Another instrumental variable study of moderate quality found no significant association between RN staffing and UTI.[28] A national study of moderate quality found that higher RN staffing was significantly associated

with higher rates of UTI.[35] Lower RN staffing may also be associated with worse outcomes (hospitalizations and mortality) for nursing home residents during norovirus outbreaks.[41]

LPN Staffing

LPN staffing may not be associated with UTI among nursing home residents (low confidence, Table 6). One study of national sample of nursing homes found no significant association between LPN staffing and rates of UTI.[35]

NA Staffing Level

Higher NA staffing may be associated with less UTI in residents (low confidence, Table 6). One national study of moderate quality found higher NA staffing was significantly associated with a decrease in the percent of residents with UTI.[35]

Total Staffing

Total staffing may not be associated with UTI (low confidence, Table 6). The study of VA CLCs found no significant association between total nurse HPRD and a composite measure of UTI, pneumonia, and pressure ulcers.[40] A national study of non-VA US nursing homes categorized total nurse staffing as ≥ 5.0 HPRD or < 5.0 HPRD, with 88% being in the latter category.[29] This study found no association between total staffing and UTI.

Nurse Skill Mix

Higher skill mix staffing may be associated with fewer UTI in nursing home residents (low confidence, Table 6). Three studies investigated the relationship between nurse skill mix and infections, and there was variation in the direction of effects across the studies.[18,29,40] One study of national sample of nursing homes defined skill mix as total licensed nurse FTE (RN and LPN) to total nurse staffing, finding that it was not significantly associated with UTI.[29] One study examining nursing homes from multiple states and using an instrumental variable approach found that higher skill mix (RN to total) was associated with fewer UTI.[18] The VA CLC study examined both percent RN staffing (of total) and percent NA staffing; it found no significant associations between either and the composite outcome of UTI, pneumonia, and pressure ulcers.[40]

Table 6. Summary Findings for Nursing Home (NH) Associated Infections

Staffing Measure or Skill Mix	Summary of Findings	Methodological Limitations	Indirectness	Imprecision	Inconsistency	Publication Bias	Overall Confidence
COVID-19 Cases and Mortality							
RN Staffing[11,39,48,49]	Higher RN staffing may be associated with lower COVID infection and mortality (likelihood and rates).	Serious[a]	Not Serious	Serious, borderline[b]	Serious[c]	Not Suspected	**Low**
LPN Staffing [49]	Higher LPN staffing may not be associated with lower resident COVID infection (likelihood) and mortality (count).	Serious[a]	Not Serious	Not Serious	—	Not Suspected	**Low**
NA Staffing[49]	Higher NA staffing may be associated with lower resident COVID infection (likelihood) and mortality (count).	Serious[a]	Not Serious	Not Serious	—	Not Suspected	**Low**
Total Staffing[11,49]	It is unknown if total staffing is associated with resident COVID infection or mortality.	Serious[a]	Not Serious	Serious, borderline[b]	Serious[d]	Not Suspected	**Very Low**
Skill Mix[49]	Higher nursing skill mix may be associated with higher resident COVID infection (likelihood).	Serious[a]	Not Serious	Not Serious	—	Not Suspected	**Low**
Other Infections							
RN[18,28,35]	Higher RN staffing may be associated with less UTI (likelihood and rates) among NH residents.	Serious[e]	Not Serious	Not Serious	Serious, borderline[f]	Not Suspected	**Low**
LPN[35]	LPN staffing may not be associated with rates of UTI among NH residents.	Serious[e]	Not Serious	Not serious	—	Not Suspected	**Low**
NA[29,35]	Higher NA staffing may be associated with fewer UTI among NH residents.	Serious[e]	Not Serious	Not serious	—	Not Suspected	**Low**
Total Staffing[50]	Total staffing may not be associated with UTI (rates and likelihood).	Serious[e]	Not Serious, borderline[g]	Not serious	Not Serious	Not Suspected	**Low**
Skill Mix[18,29,40]	Higher nursing skill mix may be associated with fewer UTI among NH residents.	Serious[e]	Not Serious, borderline[g]	Not serious	Serious, borderline[h]	Not Suspected	**Low**

Abbreviations. LPN=Licensed practical nurse; NA=Nursing assistant; RN=Registered nurse UTI=urinary tract infection.
[a] Concerns due to accuracy of COVID-19 data, timing of nursing home staffing data vs COVID-19 outcomes, and possible staff shortages due to COVID-19 outbreaks.

[b] Wide confidence intervals for some effect estimates.
[c] Three studies found significant associations, while 1 study found opposite effect (higher RN staffing was associated with higher likelihood of COVID-19).
[d] One study found no significant associations and the other study showed that both low and high total staffing (compared with middle tertile) were associated with higher COVID-19 mortality.
[e] Cross-sectional studies with outcomes reported by NH staff.
[f] Two studies showed significant associations, and 1 did not find significant association.
[g] One study used composite outcome of UTI, pneumonia, and pressure ulcers.
[h] Variable definitions of skill mix, with 1 study finding significant association and 2 studies not finding significant associations.

PAIN (MODERATE-SEVERE)

Six moderate-quality studies examined associations between nurse staffing and moderate-severe pain in nursing home residents, all using MDS 2.0 data for outcomes.[26,29,31,33,35,36] MDS 2.0 data on residents with moderate-severe pain relied on reports by nursing home staff (beginning in 2010, pain outcomes in MDS 3.0 have been assessed by resident interviews). Five studies used data for national nursing home samples,[26,29,31,35,36] and 1 study evaluated nursing homes in 6 states (Missouri, Texas, Pennsylvania, New York, Connecticut, and New Jersey).[33] Summary of findings with certainty of evidence are shown in Table 7. See Appendix Table F-3 for detailed study characteristics and results.

RN, LPN, and NA Staffing

Five studies evaluated associations between nurse staffing (measured as RN, LPN, or NA FTE per 100 residents) and rates of residents with moderate-severe pain.[26,31,33,35,36] All 5 studies were conducted by the same lead author, and all used study-specific surveys of nursing home administrators to assess nurse staffing. Across these studies, NA FTE made up more than half of total nurse staffing, ranging from 26-33 FTE per 100 residents. RN staffing ranged from 12-15 FTE and LPN staffing was 11-17 FTE.

Higher RN staffing may be associated with lower rates of moderate-severe pain among nursing home residents (low confidence). Significant results were reported by 3 studies[31,35,36]; for example, 1 of these found 0.5% less residents with moderate-severe pain (per nursing home) for every 1 FTE higher RN staffing (per 100 residents).[31] However, 2 studies did not find significant associations between RN staffing and rates of moderate-severe pain in residents.[26,33]

It was unclear if LPN and NA staffing were also associated with rates of moderate-severe pain among residents (very low confidence for both). Two studies reported that higher LPN and NA staffing were both associated with lower rates of moderate-severe pain among long-stay patients.[26,31] One study found that higher LPN and NA FTE (per 100 residents) were each associated with higher rates of moderate-severe pain in long-stay residents but lower rates in short-stay residents.[35] One study found no significant associations for either LPN or NA staffing.[33] One study reported that higher NA FTE was associated with lower rates of moderate-severe pain in both long-stay and short-stay residents.[36] This same study reported that LPN staffing had no significant association with moderate-severe pain in long-stay residents but did have significant associations with lower rates in short-stay residents.[36]

Total Staffing

It was unclear if total nurse staffing is associated with moderate-severe pain in nursing home residents (very low confidence). One study examined data for a national nursing home sample to evaluate association between total nurse staffing (RN, LPN, and NA; dichotomized at $< \text{or} \geq 5.0$ HPRD) and likelihood of NH being in the highest 75th percentile for rates of residents with moderate to severe pain.[29] The main variables of interest were NA and licensed nurse (RN and LPN) turnover rates, analyzed in separate models. In both models, total staffing was not significantly associated with the nursing home being in the top quartile for highest rates of residents with moderate to severe pain. This study did not report whether long-stay or short-stay residents (or both) were included in assessment of pain outcomes.

Nurse Skill Mix

Higher skill mix may be associated with lower rates of moderate-severe pain among nursing home residents (low confidence). Four studies evaluated associations between skill mix and rates of moderate-severe pain.[26,29,31,36] Three studies were conducted by the same lead author, defined skill mix as the ratio of RN FTE to total non-RN FTE (LPN and NA), and found that higher ratios were associated with lower rates of moderate-severe pain among long-stay residents.[26,31,36] For example, 1 of these studies reported that 1% higher RN ratio was associated with 0.2% lower rates of moderate-severe pain.[31] One of these studies also evaluated moderate-severe pain among short-stay residents but found no significant association with skill mix.[36] Finally, 1 study evaluated association between skill mix and likelihood of the nursing home being in highest 75th percentile for residents with moderate-severe pain.[29] This study measured skill mix as a ratio of total licensed nurse staffing (RN and LPN) to total direct care staffing (RN, LPN, and NA), and reported no significant association.[29]

Table 7. Summary Findings for Pain (Moderate to Severe) in Nursing Home Residents

Staffing Measure or Skill Mix	Summary of Findings	Methodological Limitations	Indirectness	Imprecision	Inconsistency	Publication Bias	Overall Confidence
RN Staffing[26,31,33,35,36]	Higher RN staffing may be associated with lower rates of moderate-severe pain among NH residents	Serious[a]	Not serious	Not serious	Not serious, borderline[b]	Not Suspected	**Low**
LPN Staffing[26,31,33,35,36]	Unknown if LPN staffing is associated with rates of moderate-severe pain among NH residents.	Serious[a]	Not serious	Not serious	Serious[c]	Not Suspected	**Very Low**
NA Staffing[26,31,33,35,36]	Unknown if NA staffing is associated with rates of moderate-severe pain among NH residents	Serious[a]	Not serious	Not serious	Serious[d]	Not Suspected	**Very Low**
Total Staffing[29]	Unknown if total staffing is associated with rates in moderate-severe pain among NH residents.	Serious[a]	Not serious	Not serious, borderline[e]	—	Not Suspected	**Very Low**
Skill Mix[26,29,31,36]	Higher nursing skill mix may be associated with lower rates of moderate-severe pain among NH residents	Serious[a]	Not serious	Not serious	Not serious, borderline[b]	Not Suspected	**Low**

Abbreviations. LPN=Licensed practical nurse; NA=Nursing assistant; RN=Registered nurse

[a] Pain outcomes reported by NH staff; most cross-sectional studies; all or most results from studies conducted by same lead author

[b] No significant association in 2 studies

[c] Association with lower rates in 2 studies, no significant association in 1 study, significant association only with lower rates for short-stay residents in 1 study, and both higher and lower rates (for long and short-stay patient outcomes, respectively) in 1 study.

[d] Association with lower rates in 3 studies, no significant association in 1 study, and both higher and lower rates (for long and short-stay patient outcomes, respectively) in 1 study.

[e] Wide confidence intervals

URINARY CATHETERS

Seven studies addressed the use of urinary catheters and all used MDS data for outcome data (see Appendix Table F-1 for detailed results).[26,28,29,31,33,35,36] All were moderate quality and conducted between 2000 and 2008. Five of the studies were from the same research group, Castle et al.[26,31,33,35,36] Six of the studies were cross-sectional, while the seventh used a longitudinal design.[31] Five studies evaluated data for national samples of nursing homes, [26,29,31,35,36] 1 looked at nursing homes only in Colorado,[28] and the seventh examined nursing homes in 6 states (Missouri, Texas, Pennsylvania, New York, Connecticut, and New Jersey).[33]

There is inconsistency in the relationship between nurse staffing and use of urinary catheters in nursing homes, with some studies finding significant associations and others finding none. All 7 addressed RN staffing levels, 5 evaluated LPN and NA staffing levels,[26,31,33,35,36] and 3 examined skill mix.[26,29,31] None of the studies addressed total nurse staffing. Four studies showed a significant association between higher RN staffing and lower use of catheters,[26,29,31,33] while the other 3 studies found no significant associations.[28,35,36] Four studies found a significant association between higher NA staffing and lower catheter use,[26,31,35,36] and 1 study found no association.[33] Two studies showed a significant association between higher skill mix and lower catheter use,[26,31] while the third study found no association.[29]

FUNCTIONING

Three studies addressed functioning in nursing home residents and all used MDS data on worsening in activities of daily living (ADL, including bed mobility, transfer, eating, and toileting) or basic mobility (able to move around the room).[33,35,51] See Appendix Table F-3 for detailed results. One high-quality study measured nurse staffing hours by observation and detailed self-reports from staff at 105 nursing homes in 4 states (Colorado, Indiana, Mississippi, and Minnesota), specifying resident-specific time (attributed by staff to individual residents) out of total direct care HPRD by RN, LPN, or NA.[51] Higher total RN HPRD was associated with lower likelihood of decline in ADL at 90 days (coefficient -0.27, OR 0.76, $p<0.05$), but LPN HPRD was associated with higher likelihood of decline (coefficient 0.25, OR 1.28, $p<0.05$); NA HPRD did not have significant association (coefficient not reported). Higher resident-specific time was associated with greater likelihood of ADL decline for RN (coefficient 0.09, OR 1.09, $p<0.05$), LPN (coefficient 0.13, OR 1.14, $p<0.05$), and NA (coefficient 0.42, OR 1.52, $p<0.001$). Notably, baseline data for ADL came from the MDS assessments closest to the time period during which nurse staffing hours were assessed; there was substantial variation in the gap between MDS assessment and nurse staffing measurement (mean 0.2 days, SD 24.2 days).

The 2 remaining moderate-quality studies were conducted by the same group and both examined worsening ADL and mobility.[33,35] One study evaluated a national sample of 2,840 nursing homes, finding that higher RN, LPN, and NA staffing were all associated with lower proportions of residents with ADL decline (coefficients -0.06 to -0.09, $p\leq0.05$).[35] For mobility, higher RN and LPN staffing were associated with lower proportion of residents with decline (coefficients -0.06 and -0.05, $p\leq0.05$), but NA staffing was associated with higher proportion with decline (coefficient 0.27, $p\leq0.05$). The other study examined data for 1,071 nursing homes from 6 states (Missouri, Texas, Pennsylvania, New York, Connecticut, and New Jersey), showing that higher RN staffing, modeled as log(FTE per 100 residents), was associated with lower proportions of residents with declines in ADL (coefficient 0.76, $p<0.01$) and mobility (coefficient 0.83,

p<0.01).[33] LPN and NA staffing were not significantly associated with declines in ADL or mobility.

QUALITY OF LIFE

Three moderate-quality studies reported on the association between nurse staffing and quality of life (see Appendix Table F-4 for detailed results).[52-54] Two studies both examined outcomes for Minnesota nursing homes, using the Minnesota Department of Human Services data on nurse staffing and in-person interviews with a random sample of residents to assess quality of life.[52,54] These state-wide interviews used a validated multi-domain instrument to measure resident quality of life and satisfaction with care.[52,54] One study found that higher RN HPRD was associated with higher summary quality-of-life scores, but LPN and NA HPRD were not associated with differences in quality of life.[52] The other study found that higher NA HPRD was associated with higher composite quality of life scores, but RN and LPN HPRD were not associated with these scores.[54] Both studies adjusted for resident case mix.[52,54]

The third study evaluated outcomes for a small number of nursing homes in western New York State.[53] This study used OSCAR data on nurse staffing and interviewed residents to assess quality of life; nurse staffing levels and skill mix were not associated with summary scores for quality of life.[53]

HOSPITALIZATIONS

One high-quality[46] and 4 moderate-quality studies[42-44,47] evaluated hospitalizations (see Appendix Table F-5 for detailed results). Three studies were longitudinal,[44,46,47] and the remaining 2 were cross-sectional.[42,43] Four studies evaluated national samples of nursing homes, using CMS claims data to determine hospitalizations for nursing home residents.[42-44,47] The fifth study used state agency data on hospitalizations for nursing homes in New York.[46] Two studies focused specifically on potentially avoidable hospitalizations (PAH) among nursing home residents before death (within 90 days[42] or within 1 year[44]).

Three studies evaluated effects of total nurse staffing levels, with 2 showing no associations with PAH within 90 days of death[42] or overall hospitalization rates.[47] The third study showed a significant association between higher total staffing and a slightly lower odds of PAH within 1 year of death (OR 0.94 [0.90, 0.99], p=0.02).[44] Two studies examined effects of RN staffing; 1 showed that higher RN staffing was associated with a small decrease in probability of 30-day readmissions,[43] and the other did not find significant associations between RN staffing and time to first hospitalization (or time between repeat hospitalizations).[46] Only 1 study examined LPN and NA staffing and found no associations between these staffing levels and probability of 30-day readmission.[43] Three studies evaluated skill mix and all 3 found an association between higher skill mix and fewer hospitalizations.[42,44,47]

DEFICIENCY CITATIONS FOR QUALITY OF CARE

Five studies addressed associations between nurse staffing and citations for a range of deficiencies (see Appendix Table F-6 for detailed results). In all studies, deficiency citations were assessed using OSCAR data. Four studies included national samples of nursing homes,[55-58] while 1 study focused on nursing homes in New York.[59] One was high quality,[57] and the remaining 4 were moderate quality.[55,56,58,59] Three studies were conducted by the same group,

used national samples of nursing homes, and evaluated separate associations with RN, LPN, and NA staffing.[55-57] One of these examined odds of nursing homes having a specific citation for infection control and hand hygiene, finding that higher RN, LPN, and NA staffing were all associated with somewhat lower odds of having a citation (OR 0.89-0.91, $p<0.05$ or $p<0.001$).[56] The other 2 studies examined counts of [55] or odds of having any citation[57] out of a number of different citations on quality of care. One of these found no association with nurse staffing (OR 0.77-1.01 for RN, LPN, and NA; $p>0.05$ for all),[55] and the other found lower likelihood of citations with higher RN staffing (OR 0.95, $p<0.01$) but higher likelihood with higher LPN staffing (OR 1.02, $p<0.05$), and no association with NA staffing (OR 1.01, $p>0.05$).[57]

The fourth national study examined associations between total nurse staffing (RN, LPN, and NA; dichotomized at <5.0 or ≥5.0 HPRD) and the likelihood of being in the highest 75% percentile in number of citations (out of the set of citations for quality of care), finding no significant association (OR 1.03, 95% CI [0.63, 1.69]).[58] This study also evaluated association with skill mix, measured as proportion of licensed nurse staffing (RN and LPN) out of total nurse staffing; there was no significant association (OR 0.99, 95% CI [0.97,1.01]).

The final study evaluated associations between nurse staffing (RN, LPN, or NA) and receiving citations for quality of care for 162 nursing homes in New York.[59] Only higher RN staffing was associated with nursing homes having lower counts of citations (coefficient -0.25, $p=0.005$); there were no significant associations for LPN or NA staffing. This study also examined associations with likelihood of receiving more serious quality of care citations, but found no significant effects for any nurse staffing variable.

OTHER OUTCOMES

Only 1-2 high- and moderate-quality studies addressed each of the following outcomes: use of antipsychotic medications,[28,60] falls with major injury,[61,62] discharge to home or community,[63] and all-cause mortality.[64] See Appendix Table F-7 for detailed results regarding these outcomes.

Antipsychotic Use

Two eligible studies reported on associations between nurse staffing and antipsychotic medications use in nursing homes.[28,60] Both were rated moderate quality and used OSCAR and Medicaid data. One study was cross-sectional and examined nursing homes in Colorado.[28] This study used least squares regression modeling and found there was no significant association between RN HPRD and antipsychotic drug use.[28] The second study was a repeated time series analysis using data from a national sample of nursing homes.[60] Using mixed effects linear models, this study found no significant association between RN HPRD and antipsychotic medications.[60] This study did find that higher LPN and NA HPRD were associated with slightly higher rates of antipsychotics use (coefficients 0.1-0.3, $p<0.05$).[60]

Falls with Major Injury

One high-quality[62] and 1 moderate-quality study[61] evaluated the association between nurse staffing and resident falls. The high-quality study was cross-sectional and the moderate-quality study used a repeated time series design. Both studies evaluated national samples of nursing homes, and used data on nurse staffing from CASPER/OSCAR and falls outcomes from Nursing Home Compare (NHC) or MDS.[61,62] These 2 studies found inconsistent results regarding nurse

staffing and residents experiencing falls. Livingstone et al[61] found that higher RN HPRD, but not LPN or NA, was associated with a statistically significant lower proportion of nursing home residents that had a fall. In contrast, Leland[62] found higher NA HPRD, but not licensed nurses (RN and LPN), was associated with significantly lower resident falls. Neither study evaluated associations between nurse skill mix and resident falls. Inconsistent results between these 2 studies may have been due to their different primary goals; 1 was focused on evaluating the relationship between occupational and physical therapy staffing and resident outcomes (with nurse staffing included as covariates),[61] whereas the other aimed to address organizational factors of nursing homes that included nurse staffing.[62]

Discharge to Home or Community

One high-quality study reported on the association between nurse staffing and discharge to the community.[63] This study evaluated 68 nursing homes who had contracted with a private company (SeniorMetrix) that assists facilities with quality improvement for their residents with Medicare Advantage. This cross-sectional study only evaluated outcomes for residents who had lengths of stay that were 100 days or shorter and used discharge data from the private company. Total nurse staffing was dichotomized at < 3.5 HPRD (34% of nursing homes) or ≥ 3.5 HPRD (66%). This study reported that residents in nursing homes with ≥ 3.5 HPRD were more likely to be discharged to the community (OR 1.53 [1.29–1.80]).

Mortality

One moderate-quality study evaluated the association between nurse staffing and rates of nursing home residents who died.[64] This longitudinal study examined 612 California nursing homes who had less total nurse staffing than was mandated by new state regulations in 2000 (3.2 HPRD). Using an instrumental approach based on the difference between actual nurse staffing (during years before the mandate) and 3.2, this study showed that higher total nursing per HPRD was associated with 6 fewer resident deaths.[64]

DISCUSSION

SUMMARY OF KEY FINDINGS

In this review, we identified 44 eligible studies that addressed the effects of nurse staffing on processes of care and resident outcomes in nursing homes (KQ 1). We did not find any eligible studies that addressed KQ 2. All eligible studies were observational in design, and the vast majority used CMS datasets to assess processes of care or resident outcomes. Only 1 study focused on outcomes in VA CLCs; no studies compared outcomes across VA CLCs and non-VA community nursing homes. The most frequently addressed outcomes were pressure ulcers and nursing home-associated infections, with one-third of the latter group evaluating COVID-19. We evaluated overall certainty of evidence for 3 high-priority resident outcomes: pressure ulcers, infections, and moderate-severe pain in residents. Key findings include the following:

- Higher RN staffing is probably associated with fewer pressure ulcers among residents of nursing homes (moderate confidence); LPN and NA staffing may also be associated with fewer pressure ulcers (low confidence)

- Total nurse staffing is probably not associated with pressure ulcers in residents (moderate confidence), but higher skill mix may be associated with fewer pressure ulcers (low confidence)

- Higher RN and NA staffing, and higher skill mix may be associated with lower resident COVID-19 infection and mortality in nursing homes, while LPN staffing may not be associated with COVID-19 outcomes (low confidence for all findings)

- Higher RN staffing and skill mix may be associated with less UTI among nursing home residents, while LPN, NA, and total staffing may not be associated with rates of UTI (low confidence for all findings)

- Higher RN staffing and skill mix may be associated with lower rates of moderate-severe pain among nursing home residents (low confidence), but it is unclear if LPN, NA, and total staffing are associated with pain outcomes (very low confidence)

- Only 1-2 studies addressed effects of nurse staffing on use of antipsychotics medications, falls with major injury, discharge to community, and all-cause mortality

- Results for other resident outcomes and processes of care were largely inconsistent across studies, and sometimes within the same study

Since our initial search, another observational study evaluating COVID-19 outcomes in nursing homes was published; total nurse staffing and skill mix (RN and LPN to total staffing) were not associated with COVID-19 rates or mortality during June-September 2020.[65] This study used CMS mandated data on COVID-19 infections for a national sample of nursing homes. Overall, results from this study did not substantially change our findings for COVID-19.

Nursing home administrators must determine the optimal nurse staffing that is financially feasible and maximizes resident outcomes. Resources needed to employ sufficient nursing staff

must be balanced against needs in other areas, such as environmental safety and recreational services. We have found only observational studies that examined the relationship between nurse staffing and processes of care and resident outcomes. The use of CMS mandated data to study nursing home outcomes is powerful and practical, but presents several concerns. CMS data (*eg*, OSCAR/CASPER and MDS) were not collected for research purposes, but to meet federal requirements for nursing homes. As these data directly inform payment or ability to operate, and most are reported by nursing home staff, there may be under-reporting of certain outcomes and over-reporting of staffing levels. In 2016, CMS switched to PBJ for nurse staffing, which required that staffing data is based on payroll (or other auditable information).[66] However, most eligible studies used CMS staffing data collected before implementation of PBJ. Additionally, in many studies, outcomes data were not clearly collected after nurse staffing data, which may also change over time. CMS data captures nurse staffing at a certain time or averaged over some time period. This presents challenges for understanding the potential impact of fluctuations in nurse staffing (*eg*, over intervening weeks or differences between weekdays and weekends). Timing of data collection is likely also not ideal for capturing rates of acute outcomes such as nursing home-associated infections. These methodological concerns limit the ability to detect true associations, and may contribute to counter-intuitive results, such as when insufficient nurse staffing leads to under-detection of pressure ulcers or pain among residents. Staffing assessment of patient-centered outcomes (*eg*, pain) may also substantially differ from resident or family reports. This concern has been addressed by changes in MDS 3.0 data collection (beginning in 2010) that now incorporate resident interviews, but none of the eligible studies examining these outcomes used MDS 3.0 data.

Notably, studies for 2 outcomes (COVID-19 infections and quality of life) often used data sources outside of these CMS datasets. COVID-19 studies used a variety of sources including state agency data and reports from news organizations to capture COVID-19 cases and mortality. However, these studies still used CMS data on nurse staffing, which are collected once a year; although studies selected the timepoint for staffing data before the time period when COVID-19 infections occurred, these studies would not have captured any fluctuations in staffing during the early stages of the pandemic. Several studies on quality of life used in-person interviews with nursing home residents, but these were limited to data for nursing homes in a single state.

Finally, variation across studies in analytic approaches, definitions of nurse staffing, and outcomes measures presented substantial challenges for interpretation and synthesis of results. Nurse staffing measures included separate effort or hours for RN, LPN, or NA, and also total nurse staffing or total licensed nursing (RN and LPN). Similarly, there was different measures of skill mix, with some focusing on RN effort or time. Because these staffing measures are related and these relationships may vary depending on state-level regulations regarding specific types of nurse staffing, the analytic approaches likely impacted whether individual studies may be able to detect separate effects due to RN, LPN, and NA staffing. Studies used a variety of analytic approaches, included mixed effects models and instrumental variables approaches. In particular, some studies evaluated data before and after policy changes regarding nursing home regulations, taking advantage of a natural experiment to evaluate the causal relationship between nurse staffing and resident outcomes. Past reviews of how nurse staffing affects resident outcomes have noted similar challenges in summarizing and interpreting the evidence from such observational studies; these have generally found mixed results across studies for a variety of outcomes with some limited evidence for better outcomes with higher staffing.[67-69]

There remain substantial challenges to observational analyses of the relationship between nurse staffing and resident outcomes. Nursing homes are complex, heterogenous environments. They are regulated by multiple federal, state, and other agencies. Even high-quality observational studies may not be able to account for all resident population and facility confounders. Nurse staffing may play a key role in resident outcomes, but they are not the only factor. Other providers (*eg*, physicians, physician extenders, and allied health professionals), the physical environment, and policies within a nursing home also affect resident outcomes. The number of these other factors and the complexity of how they interplay was detailed in conceptual models employed in multiple eligible studies. Data were generally not available for all of these confounding factors or often had substantial limitations in accuracy. Thus, it is generally difficult to separate causal effects of nurse staffing versus higher nurse staffing (or skill mix) as an indicator of generally positive environments or higher resources in nursing homes.

IMPLICATIONS FOR VA POLICY

This review summarizes the evidence regarding the effects of nurse staffing on resident outcomes and processes of care. We found only 1 eligible study that evaluated these effects for VA CLCs. There are substantial concerns in generalizability of results from studies of non-VA US nursing homes to VA CLCs. VA CLC residents are likely very different from the average community nursing home resident. Federal law and VA policies require VA to treat any qualifying Veteran, regardless of ability to pay and especially if care needs reflect injuries or conditions related to past military service (*ie*, service-connected conditions). This requirement, along with being hospital-based facilities, likely lead to VA CLC residents having demographic differences, more health conditions and care needs, and overall greater acuity, compared with community nursing home residents.[70] For example, most CLC residents are male, are younger, and have higher rates of certain conditions (*eg*, PTSD),[71,72] compared with majority women and lower rates of mental health concerns in community nursing home residents. These differences may contribute to higher rates of certain outcomes (*eg*, pressure ulcers) in VA CLC residents.[70] Furthermore, by VA policies, VA CLCs must have higher levels of nurse staffing (particularly RN staffing), compared to community nursing homes. For example, the single eligible study on VA CLCs showed that the average total nurse staffing was 4.6 HPRD, with 31% being RN staffing; this would be an average of 1.4 RN HPRD for each CLC. Community nursing homes generally had much less RN HPRD. Beyond staffing levels, there are likely other important differences in the nursing workforce and work environment between VA CLCs and community nursing homes. Therefore, the results regarding improved resident outcomes with higher RN staffing in community nursing homes may be less applicable to VA CLCs.

Aside from these concerns regarding applicability, larger environmental factors (*eg*, nursing shortages) may present substantial challenges to increasing nurse staffing. Nursing homes may also be less desirable employers compared with other facilities (*eg*, hospitals) that also need nursing staff, due to differences in salary and benefits, or other factors in the work environment. Additionally, our results suggest very small potential differences in resident outcomes associated with nurse staffing. For example, 1 study showed that 1 FTE higher of RN staffing per 100 residents reduced the rate of moderate-severe pain in residents by 0.5%[31]; this indicates that 2 additional FTE of RN staffing in a nursing home with 100 residents are needed to prevent 1 case of pain. Using a publicly available estimate of $75,000 for salary and benefits for RN,[73] it would take $150,000 to prevent 1 resident from having moderate-severe pain. VA salaries for RNs are often higher, leading to even greater costs for VA.

Although outside the scope of this current review, VA CLCs may wish to consider changes beyond nurse staffing in order to improve specific resident outcomes. Other potential options include modifications to the nursing home environment and processes (*eg*, engaging all nurse staffing in care planning), and greater resources for other allied health professionals (*eg*, social workers and mental health staff). Some of these measures have been implemented by certain VA CLCs, including specialized teams to address mental health and behavioral symptoms among residents with dementia.[74]

RESEARCH GAPS/FUTURE RESEARCH

We identified only 1 eligible study on nurse staffing and resident outcomes in VA CLCs; this focused on a composite outcome of pressure ulcers, pneumonia, and UTI. To better understand relationships between nurse staffing and other outcomes in VA CLCs, we recommend conducting additional studies using VA data and relevant study-specific assessments. Due to concerns noted above regarding applicability of results from non-VA community nursing homes, future studies should directly address these relationships for other outcomes in VA CLC residents.

Additionally, dedicated assessments of nurse staffing and resident outcomes in observational studies may provide a more accurate evaluation of the effects of nurse staffing. It would also be valuable to include data on organizational culture and other structural characteristics of nursing homes that are not usually reflected in CMS datasets. Although CMS has recently started to require reporting of nurse turnover and weekend nurse staffing,[75] there remain many other aspects of staffing and work environment that are likely important for resident outcomes but not captured by CMS data.

Finally, all identified evidence regarding the effects of nurse staffing came from observational studies. Randomized trials of nurse staffing may be logistically challenging and also may engender substantial ethical concerns (*eg*, lowering nurse staffing below currently accepted levels may create unacceptable risks for resident safety). However, the complex relationships between nurse staffing, other nursing home facility characteristics, and resident factors make it very difficult to understand causal effects of nurse staffing from observational studies alone. One possible avenue to address these concerns may be to take an implementation science perspective, and consider whether certain study designs (*eg*, stepped wedge[76]) may be used to incorporate randomization in real-world setting and more rigorously examine the effects of nurse staffing. For example, a new initiative could offer more resources for nurse staffing to participating nursing homes, with different facilities randomly selected to increase staffing over different time periods. If such a study were conducted within an integrated regional or national health system, such as the VA, there may be additional opportunities to leverage existing infrastructure for resident health information that would provide more timely and accurate information than CMS datasets.

LIMITATIONS

This evidence review has several limitations. The focus of this review was on nursing home staffing, and not on other organizational or structural factors of nursing homes that may be important for resident outcomes. We also limited results to resident outcomes and processes of care to those that were of interest to our stakeholders. Because our goal was to inform current policy and decision-making within the VA, we also limited eligibility to studies of US nursing

homes using data from 2000 or later. Nursing homes are governed by a complex set of national (or more local) regulations, which have substantially changed since 2000 and may be very different for other countries. Training and experience for different types of nursing staff may also vary across different countries. There may also be differences in resident characteristics of non-US nursing homes, related to regulations and financial policies for nursing home benefits. Therefore, our results are likely not applicable to the effects of nurse staffing in non-US nursing homes.

CONCLUSIONS

Evidence on nurse staffing and resident outcomes and processes of care come from observational studies. Higher RN staffing and skill mix were associated with fewer pressure ulcers, fewer nursing home-associated infections, and lower rates of moderate-severe pain. Effects of LPN, NA, and total staffing were mixed or unclear for these outcomes. Relationships between nurse staffing and a variety of other outcomes were inconsistent, or only evaluated by 1-2 studies. These findings may not generalize to VA CLCs, which have different resident characteristics and higher staffing levels than non-VA community nursing homes. More accurate and randomized study designs may be required to definitely evaluate the effects of nurse staffing on resident outcomes and processes of care.

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