The Effectiveness of Targeted Gown and Glove Use by Healthcare Personnel in Long Term Care Facilities: A Systematic Review

Plain Language Summary

Background

Multidrug resistant organism (MDRO) transmission negatively impacts the resilience of health systems and causes substantial morbidity and mortality among residents of long-term care facilities (LTCF). When considering the hierarchy of controls to reduce the layers of infection prevention and control , personal protective equipment are generally less effective than other elements but remain a critical component in healthcare settings. In addition, the use of Contact Precautions can be challenging in LTCF where restriction of residents to their rooms can have negative impacts on quality of life and is not feasible for LTCF residents with MDROs, which can result in colonization that lasts for months or years. LTCFs strive to maintain a home-like environment, which can be at odds with the use of Contact Precautions. Considering this, the Centers for Disease Control and Prevention developed guidance to implement the targeted use of gowns and gloves, in LTCF. Importantly, the effectiveness of the use of gowns and gloves, or gloves alone, for higher risk residents and activities has not been assessed with a systematic review.

Research Question

For healthcare personnel, what is the effectiveness of risk-based use of gowns and gloves, or gloves alone, to prevent transmission of pathogens?

Methods

Authors searched MEDLINE, EMBASE, Global Health (OVID), Cochrane Library, Nursing and Allied Health Database (ProQuest), and Scopus, and included all studies that evaluated the effectiveness of the risk-assessed use of gowns and gloves, or gloves alone, to **prevent transmission of pathogens to HCP or residents**. Data was extracted, critically appraised, and all outcomes were narratively aggregated.

Results

The literature review identified one before-after study that reported a decrease in *Staphylococcus aureus (S. aureus*) and methicillin-resistant *S. aureus* (MRSA) acquisition rates in a two-month period in two LTCFs after the implementation of gown and glove use targeted to higher-risk residents and higher-risk care activities. Higher-risk residents were those with wounds which required a dressing or those with medical devices, and higher-risk care activities included dressing, bathing, transferring, providing hygiene, changing linens, changing briefs or diapers, medical device care or use, and dressing wounds. The literature review identified two multicenter cohorts reporting indirect data consisting of MRSA and resistant Gram-negative bacteria (RGNB) contamination of gowns and gloves in four papers. The evidence suggested MRSA contamination of HCP gloves and gowns was associated with hygiene assistance and bathing, while MRSA contamination of gloves alone was associated with wound care. RGNB contamination of gloves was associated with resident bathing. The evidence was insufficient to determine which resident characteristics are associated with an increase in gown or glove contamination by either MRSA or RGNB.

Context

This is the first systematic review to assess evidence on the targeted use of gowns and gloves. In light of the current MDRO burden and the nuances of healthcare delivery in LTCFs, the limited evidence suggests a benefit to the use of gowns and gloves targeted to higher risk residents has potential to interrupt transmission in residential facilities facing challenges with implementing Contact Precautions to reduce MDRO transmission.

Introduction

The Healthcare Infection Control Practices Advisory Committee (HICPAC) is a federal advisory committee to the Centers for Disease Control and Prevention (CDC), that provides advice and guidance on infection prevention and control (IPC) in healthcare settings to the agency. One of HICPAC's chartered functions is to provide recommendations to CDC on the update of CDC's infection control guidelines. In 2021, HICPAC created a workgroup to update the CDC Guideline for Isolation Precautions, 2007, with expertise in the fields of infectious disease, infection prevention, occupational health, nursing, healthcare epidemiology, and healthcare management with technical input from CDC including from the Division of Healthcare Quality Promotion (DHQP) and the National Institute of Occupational Safety and Health (NIOSH). One of the primary functions of this workgroup was to reassess the categories of transmission-based precautions (TBP). It is important to highlight that TBP categories are developed to be applied across pathogens and categories of pathogens to prevent transmission during routine resident care. TBP categories are not developed to be specific to one single pathogen. It is in this broader context that the workgroup was tasked by the committee to review the 2007 TBP categories to see if the elements of PPE within each category require changes, or if, in a post-pandemic era, entirely new categories are needed. Gown and glove use for higher-risk individuals or procedures is a new category of TBP considered for inclusion in the update, and which the Workgroup reviewed.

Residents of skilled nursing and LTCFs experience high rates of MDRO colonization or infection, including MRSA, which results in increased morbidity, mortality, and costs. Recent estimates of MDRO prevalence have exceeded 50%.[1-9] Interrupting MDRO transmission becomes challenging in these settings due to the tension between quality of life and restrictions that accompany some IPC measures. In 2019, CDC published implementation guidance on the targeted use of gowns and gloves for situations where Contact Precautions do not apply.[10] Examples of these situations include when residents are infected or colonized with an MDRO, or simply have wounds or indwelling medical devices, which are risk factors for MDRO colonization and infection in LTCFs.[11] HICPAC provided implementation considerations for gown and glove use for higher risk activities and residents that included education and training, signage, and the location of EBP supplies.[12] To date, there is no systematic review examining the effectiveness of targeted gown and glove use for higher risk residents and activities, in healthcare facilities.

Methods

This document was created at the request of the Isolation Guideline Update Workgroup (hereafter referred to as the Workgroup) of HICPAC to inform their work to update to the Guideline for Isolation Precautions, 2007. The Workgroup membership consists of subject matter expertise in the fields of infectious disease, infection prevention, occupational health, nursing, healthcare epidemiology, and healthcare management. Federal technical expertise was available to answer workgroup questions with representation from CDC, and specifically DHQP and NIOSH.

Topic & Question Development

The workgroup requested technical input from CDC in the form of a systematic literature review to answer the following question:

- For healthcare personnel, what is the effectiveness of risk-based use of gowns and gloves, or gloves alone, to prevent transmission of pathogens?

Literature Search & Study Selection

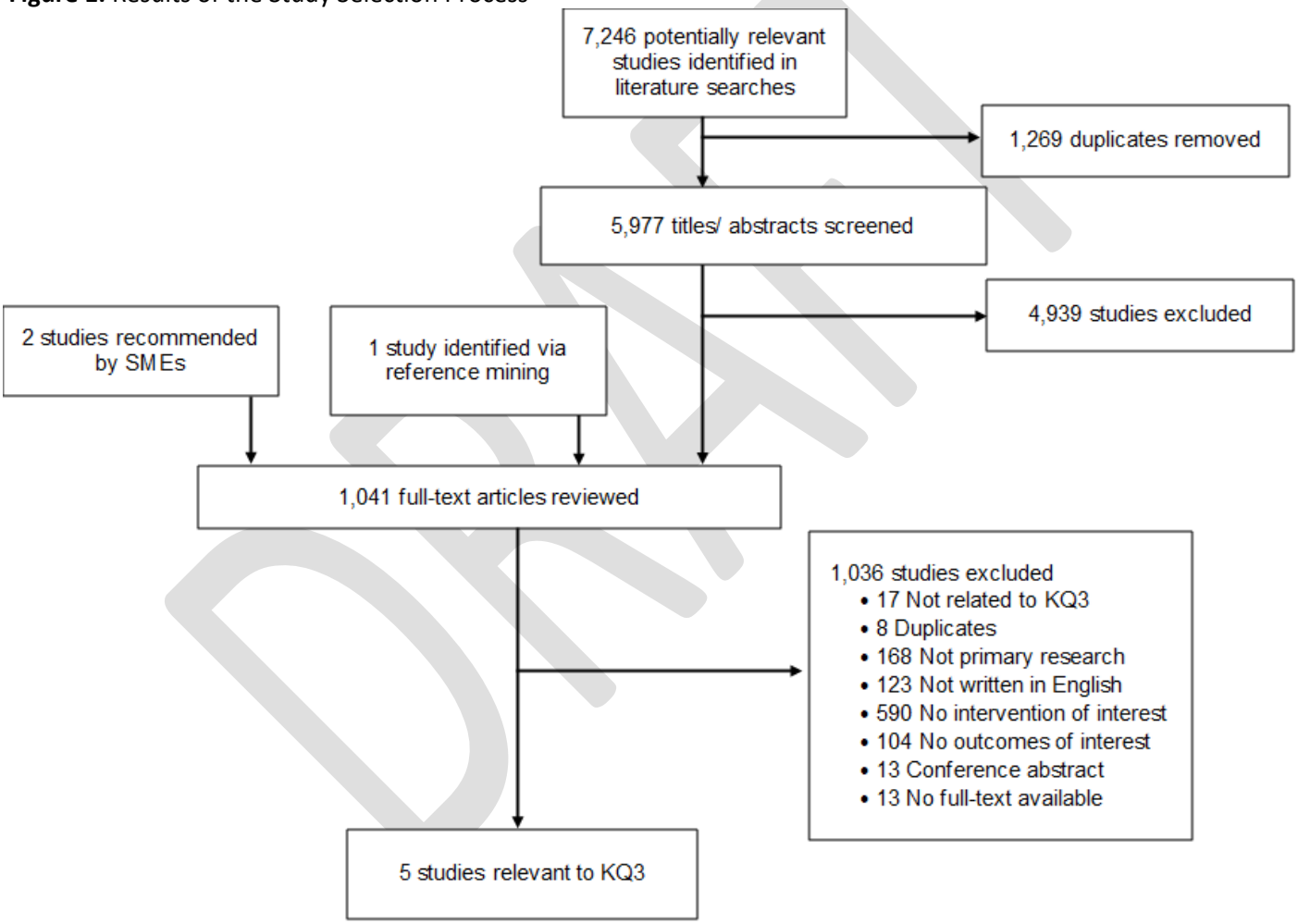
A CDC informationist (J.T.) developed search strategies from the key question and performed these searches in MEDLINE, EMBASE, Global Health (OVID), Cochrane Library, Nursing and Allied Health Database (ProQuest), and Scopus from the start of each database to January 19, 2023. Potentially relevant titles and abstracts retrieved by the literature search were uploaded into Covidence[13] and screened by two reviewers (D.O.S., C.N.S., E.C.S.), and included if they were relevant to the research question. The populations of interest were HCP and patients, and the interventions of interest included use of gowns and gloves or gloves alone for higher risk patients and activities, compared to any precautions. Full-text articles of these selected articles were also screened by two reviewers (D.O.S., C.N.S., E.C.S.). Full-texts were excluded if they met one of the following criteria:

- No full-text available;

- Not written in English;
- Not conducted in humans;
- Not primary research;
- Conference abstract or poster;
- No population of interest;
- No intervention of interest (e.g., double gloving, multi-modals, or reuse of PPE);
- No comparator;
- No outcomes of interest;

To ensure completeness of the review, reviewers examined the bibliographies of relevant systematic literature reviews and meta-analyses. All studies included and analyzed in these reviews were screened as above. The results of the study selection process are depicted in *Figure 1.*

Figure 1. Results of the Study Selection Process



Data Extraction and Evaluation

Studies meeting inclusion criteria were reviewed, critically appraised, and relevant data were extracted by two reviewers into standardized evidence tables. Data were extracted as presented in the studies. Extractions are available in Table 6. Critical appraisal of individual studies was conducted using the Internal Validity Assessment (IVA) Tool developed by the Division of Healthcare Quality Promotion at the CDC. The IVA tool consists of 34 signaling prompts abstracted from validated critical appraisal tools, that guide the identification of critical threats to the internal validity of each study.[14-18] These threats are then used to guide the assessment of confidence in the findings for each outcome. Appendix Section D

in this document includes the signaling prompts used to assess the threats to internal validity across the domains of study conduct, and the results of the internal validity assessment for the current review are presented in the Supplemental File A.

Data Synthesis

The primary outcome for this effort was lab-confirmed colonization or infection of any pathogen. Secondary outcomes sought in the literature included contamination of gowns or gloves by any pathogen and patient- or resident-related adverse events associated with targeted gown and glove use (e.g., stigma). All outcomes were narratively aggregated if more than one study reported the same outcome (Table 5). At the outset of this effort, the data analysis plan included analyzing the data using a random effects model in RStudio[19] if sufficient data was retrieved by the review and was homogenous. However, the available data did not support the conduct of a meta-analysis.

GRADE-ing Evidence

The evidence for each outcome was assessed according to its strength, direction, consistency, and directness across all studies. The assessment of each of these domains was scored according to the GRADE[20] methodology. These were narratively summarized into an overall confidence in the evidence which included an assessment of the likelihood that the findings will change.

Results

The literature review retrieved one before-after study reporting the outcome of MRSA acquisition[21], and two multicenter cohort studies described in four articles reporting the outcomes of MRSA and RGNB contamination.[22-25] The before-after study examined the implementation of targeted gown and glove use in conjunction with education and training, and process evaluations using human factors engineering compared to standard precautions. The two cohort studies examined contamination of HCP gowns and gloves after routine care activities for residents. All studies were conducted among residents and HCP in community[21,24,25] and Department of Veterans Affairs (VA)[22,23] LTCFs in the United States.

Primary Outcome

Limited evidence from one before-after implementation study[21] (N = 221 residents) suggests a benefit to the implementation of gown and glove use for higher risk residents and care activities, however, it is possible that this assessment will change with the publication of new studies (Table 3). The study was conducted in two independently functioning community-based nursing homes in the United States (U.S.) and used a participatory approach to the iterative development of a multicomponent intervention that included training and human factors assessments to implement targeted gown and glove use for higher-risk care activities in higher-risk residents. Authors reported a decrease in the odds of *S. aureus* colonization [OR: 0.35 (95% CI: 0.15-0.86), p = 0.02] and MRSA colonization [OR: 0.28 (95% CI: 0.08 - 0.92), p = 0.026], but not MSSA colonization. Additionally, this study reported a reduction in resident-to-resident transmission of *S. aureus* colonization [OR: 0.13 (95% CI: 0.02 - 1.12), p = 0.06]. Higher-risk residents included those with wounds which required a dressing or those with medical devices such as urinary catheters, vascular catheters, or feeding tubes. Higher-risk care activities included dressing, bathing, transferring, providing hygiene, changing linens, changing briefs or diapers, medical device care or use, and dressing wounds. After the intervention, gown use during higher-risk care activities was 78%, and 97% of higher-risk residents were correctly identified for targeted glove and gown use. This study did not assess compliance with Standard Precautions before the intervention, nor did authors adjust for confounding factors including HCP-to-resident ratios and resident characteristics (e.g., type of wound, or type of device).

Secondary Outcomes

Two multicenter cohort studies, one conducted in the VA[23,24] and another conducted in community long-term acute care (LTAC) facilitiess[22,26] reported on the contamination of gowns and gloves used by HCP during routine care activities. These two cohorts were reported in four studies: Two studies reported on contamination of PPE by MRSA,[24,26] with a colonization prevalence of 47%[24] and 28%[25] at enrollment. Two studies reported on the contamination of PPE by RGNB, and the prevalence of resident colonization by at least one RGNB at enrollment was 31%[23] and 19%[22]. The overlap in VA

and community LTAC resident populations, and the likelihood of single residents with contamination by multiple pathogens, prevents the aggregation of all MDRO outcomes across these four studies.

The evidence from two studies[24,26] suggests an increase in the odds of MRSA contamination of both gowns and gloves is associated with the resident care activities of dressing and providing hygiene (e.g. brushing teeth, combing hair). When examining contamination of either gowns or gloves, the evidence from the two studies reporting on RGNB was inconsistent on the activities associated with an increased odds of contamination.[22,23] Contamination of gloves was associated with resident bathing in both studies.

The evidence was insufficient to determine which resident characteristics are associated with an increase in gown or glove contamination by either MRSA or RGNB. None of the four studies conducted power calculations nor did they adjust for confounding factors such as HCP delivering care, delivery of multiple care tasks simultaneously, or HCP-to-resident ratios, which decreases confidence in these findings. Table 1 identifies the care activities and resident factors associated with PPE contamination in each study. It is likely that these results will change with the publication of new studies (Table 4).

Table 1. Resident Care Activities and Resident Factors with Significant Odds of MDRO Contamination by PPE Type

Activities	**Glove**	**Gown**
Assisting resident with hygiene (brushing teeth, combing hair)	MRSA[24,25] and RGNB[23]	MRSA[24,25] and RGNB[23]
Bathing resident	MRSA[24,25] and RGNB[22,23]	MRSA[24,25] and RGNB[23]
Wound dressing/ care	MRSA[24,25] and RGNB[22]	MRSA[24]
Changing resident briefs/ diaper	MRSA[25] and RGNB[22]	MRSA[25] and RGNB[23]
Dressing the resident	MRSA[25]	MRSA[24,25]
Assisting resident with toileting	RGNB[23]	RGNB[22]
Transferring resident	--	MRSA[25] and RGNB[22]
Changing linens	MRSA[25]	MRSA[25]
Device care	--	RGNB[23]
Showering resident	RGNB[22]	RGNB[22]

While cost was not an outcome of interest for the current systematic review, the search retrieved a cost analysis based on the MRSA study conducted in the community LTCF.[25,26] This cost analysis found that the addition of gown and glove use for higher-risk care to Standard Precautions for all residents increased the average cost per resident from US$100 (SD: $77) to US$223 (SD: 127). This cost increase was lower when the use of gown and gloves during higher-risk care, in addition to Standard Precautions, was restricted to residents with MRSA colonization [US$137 (SD: $120)] identified by active surveillance or chronic skin breakdown [US$125 (SD: $109)]. It is important to highlight that a resident-focused risk assessment, instead of task-focused risk assessment , might maintain stigma associated with gown and glove use. Further, there is uncertainty in these projected costs given the standard deviation for each.

Finally, no studies were retrieved that reported resident-associated adverse events associated with gown and glove use for higher risk residents and activities.

Discussion

This is the first systematic review to examine the evidence on gown and glove use for higher-risk residents and procedures in any setting. Evidence on the impact of implementing an intervention that entails the use of gowns and glove for higher risk residents and procedures is limited to direct evidence from one before-after trial and indirect evidence from two studies that identified activities which are associated with higher risk of gown and glove contamination. Of note, these studies did not assess the real-world effectiveness of Standard Precautions or Contact

Precautions in LTCF for reducing MDRO transmission and the current review did not retrieve evidence that directly compares the two approaches. While there is limited direct evidence on the impact of gown and glove use for higher irks residents and activities on MDRO transmission, it is important to consider the evidence in the current review in the context of resident needs in the LTCF setting. The evidence of high rates of MDRO in this setting[1-9] and the associated morbidity and mortality requires innovative solutions. Isolation and Contact Precautions have been associated with unwanted restrictions for residents in their home. These includes constraints on resident mobility, potential stigma, and decreased interactions with residents that might lead to feelings of anxiety and depression in residents and their families.[27-30] The before-after study[21] included in the current review, intentionally incorporated a participatory ergonomics approach to the implementation of risk-assessed gown and glove use through stakeholder engagement, education, and training. Any interventions that are designed to reduce MDRO transmission (e.g., Contact Precautions, pathogen reduction) will have associated implementation requirements; it is not clear whether the implementation considerations for risk-assessed precautions exceed those for any others but using a participatory ergonomics approach in healthcare has demonstrated value with implementation and acceptance.[34-40]

Appendix to The Effectiveness of Targeted Gown and Glove Use by Healthcare Personnel in Long Term Care Facilities: A Systematic Review

A. Search Strategies

Table 2. Primary Search of MEDLINE (OVID), Embase (OVID), CINAHL (Ebsco), Scopus, Cochrane Library, and Clinicaltrials.gov

Database	Strategy	Run Date	Records
Medline (OVID) 1946-	Gloves, Surgical/ OR Gloves, Protective/ OR ((Personal protective equipment/ OR (Personal protective equipment* OR PPE).tw,kf,hw.) AND (glove* OR gown*).tw,kf,hw.) AND Exp Health personnel/ OR exp health facilities/ OR (Healthcare OR health care OR health personnel OR nurse* OR doctor* OR physician* OR health worker* OR hospital*).tw,kf,hw. AND Exp Infection control/ OR exp Disease Outbreaks/ OR exp Cross Infection/ OR exp Disease Transmission, Infectious/ OR (infect* OR nosocomial OR transmit* OR transmission* OR contaminat*).tw,kf,hw. Limit to English	01/19/2023	1367
Embase (OVID) 1974-	"Surgical Glove"/ OR "Protective Gloves"/ OR (("protective equipment"/ OR ("Personal protective equipment*" OR PPE).tw,kf,hw.) AND (glove* OR gown*).tw,kf,hw.) AND exp "Health care personnel"/ OR exp "health care facility"/ OR (Healthcare OR "health care" OR "health personnel" OR nurse* OR doctor* OR physician* OR "health worker*" OR hospital*).tw,kf,hw. AND exp "Infection control"/ OR exp epidemic/ OR exp "Cross Infection"/ OR exp "Disease Transmission"/ OR (infect* OR nosocomial OR transmit* OR transmission* OR contaminat*).tw,kf,hw. Remove medline records; remove conference abstract status ; limit to English	01/19/2023	548 - duplicates =498
Cochrane Library	[mh ^"Gloves, Surgical"] OR [mh ^"Gloves, Protective"] OR (([mh ^"Personal protective equipment"] OR (("Personal protective" NEXT equipment*):ti,ab,kw OR PPE:ti,ab,kw)) AND (glove*:ti,ab,kw OR gown*:ti,ab,kw)) AND [mh "Health personnel"] OR [mh "health facilities"] OR (Healthcare:ti,ab,kw OR "health care":ti,ab,kw OR "health personnel":ti,ab,kw OR nurse*:ti,ab,kw OR doctor*:ti,ab,kw OR physician*:ti,ab,kw OR ("health" NEXT worker*):ti,ab,kw OR hospital*:ti,ab,kw) AND	01/19/2023	95 - duplicates =20

Database	Strategy	Run Date	Records
	[mh "Infection control"] OR [mh "Disease Outbreaks"] OR [mh "Cross Infection"] OR [mh "Disease Transmission, Infectious"] OR (infect*:ti,ab,kw OR nosocomial:ti,ab,kw OR transmit*:ti,ab,kw OR transmission*:ti,ab,kw OR contaminat*:ti,ab,kw)		
CINAHL (EbscoHost)	(MH "Gloves, Surgical") OR (MH "Gloves, Protective") OR (((MH "Personal protective equipment") OR ((TI "Personal protective equipment*" OR AB "Personal protective equipment*" OR SU "Personal protective equipment*") OR (TI PPE OR AB PPE OR SU PPE))) AND ((TI glove* OR AB glove* OR SU glove*) OR (TI gown* OR AB gown* OR SU gown*))) AND (MH "Health personnel+") OR (MH "health facilities+") OR ((TI Healthcare OR AB Healthcare OR SU Healthcare) OR (TI "health care" OR AB "health care" OR SU "health care") OR (TI "health personnel" OR AB "health personnel" OR SU "health personnel") OR (TI nurse* OR AB nurse* OR SU nurse*) OR (TI doctor* OR AB doctor* OR SU doctor*) OR (TI physician* OR AB physician* OR SU physician*) OR (TI "health worker*" OR AB "health worker*" OR SU "health worker*") OR (TI hospital* OR AB hospital* OR SU hospital*)) AND (MH "Infection control+") OR (MH "Disease Outbreaks+") OR (MH "Cross Infection+") OR (MH "Disease Transmission, Infectious+") OR ((TI infect* OR AB infect* OR SU infect*) OR (TI nosocomial OR AB nosocomial OR SU nosocomial) OR (TI transmit* OR AB transmit* OR SU transmit*) OR (TI transmission* OR AB transmission* OR SU transmission*) OR (TI contaminat* OR AB contaminat* OR SU contaminat*)) Exclude Medline records ; Limit English	01/19/2023	198 - duplicates =114
Scopus	(INDEXTERMS("Gloves, Surgical") OR INDEXTERMS("Gloves, Protective") OR ((INDEXTERMS("Personal protective equipment") OR TITLE-ABS-KEY("Personal protective equipment*" OR PPE)) AND TITLE-ABS-KEY(glove* OR gown*))) AND (INDEXTERMS("Health personnel") OR INDEXTERMS("health facilities") OR TITLE-ABS-KEY(Healthcare OR "health care" OR "health personnel" OR nurse* OR doctor* OR physician* OR "health worker*" OR hospital*)) AND	01/19/2023	194 - duplicates =54

Database	Strategy	Run Date	Records
	(INDEXTERMS("Infection control") OR INDEXTERMS("Disease Outbreaks") OR INDEXTERMS("Cross Infection") OR INDEXTERMS("Disease Transmission, Infectious") OR TITLE-ABS-KEY(infect* OR nosocomial OR transmit* OR transmission* OR contaminat*)) AND NOT INDEX(medline)		

B. Brief Summary of Findings

B.1. Brief Summary of Findings on the Effectiveness of Targeted Gown and Glove Use by HCP to Prevent Transmission

Table 3. Evidence Snapshot of the Effectiveness of a Multi-component Strategy Including Targeted Gown and Glove Use to Prevent MRSA Transmission among Residents (additional details and citations for footnotes are found in Table 5 and Table 6.)

Outcome	Summary	Studies	Strength	Precision	Consistency	Directness	Confidence
MRSA colonization/ acquisition	Evidence is insufficient to determine an association between a multi-component strategy including targeted gown and glove use and reduction in MRSA colonization among residents.	1 study[21] (N = 221 residents)	Serious Concerns [1]	Serious Concerns [2]	Serious Concerns [3]	No Concerns	Serious Concerns [4]

Table 4. Evidence Snapshot of the Association between Routine Care Activities and Contamination of Gowns and Gloves

Outcome	Summary	Studies	Strength	Precision	Consistency	Directness	Confidence
MRSA contamination of HCP PPE	Evidence suggests an association between MRSA contamination of gowns and gloves while dressing and providing hygiene (e.g. brushing teeth, combing hair) to a resident.	2 studies[24,25] (N = 601 residents)	Serious Concerns[1]	Serious Concerns [2]	No Concerns	No Concerns	Serious Concerns [4]
RGNB contamination of HCP PPE	Evidence suggests resident bathing is associated with an increase in RGNB contamination of gloves.	2 studies[22,23] (N = 584 residents)	Serious Concerns[1]	Serious Concerns[2]	Serious[3] Concerns	No Concerns	Serious Concerns [4]

[1] All five studies are at risk of confounding by delivery of concurrent healthcare tasks, healthcare personnel training, resident characteristics, and location of contamination on gowns.
[2] All measures of association are reported with wide confidence intervals, or the precision is unclear because confidence intervals were not reported. All studies did not report power calculations and it was unclear whether these studies were adequately powered to detect a result.
[3] Inconsistency cannot be assessed with only one study or results are inconsistent.
[4] It is likely that these results may change.

C. Narrative Evidence Synthesis and Extracted Data

C.3. Narrative Synthesis of the Effectiveness of Targeted Gown and Glove Use by HCP to Prevent Transmission

Table 5. MDRO Contamination of HCP PPE and Resident Care Activities

Outcome	Results
MRSA Contamination of HCP PPE	Two studies[24,25] (N = 601 residents) conducted in nursing care facilities (VA and community) suggest an increase in the odds of MRSA contamination of gowns and gloves is associated with dressing a resident and providing hygiene (e.g. brushing teeth, combing hair). The evidence is insufficient to determine an association between resident characteristics such as presence of wounds or devices, and other care delivery activities such as transfers, dressing changes, and diaper changes. • Strength of evidence: Both studies are at risk of confounding by delivery of concurrent healthcare tasks, healthcare personnel training, resident characteristics, and location of contamination on gowns. • Consistency of evidence: The evidence is consistent for some activities, and inconsistent for others. • Precision of evidence: Precision of the evidence is low. Neither study conducted power calculations, and only one study[24] reported confidence intervals which were wide. • Directness of evidence: The resident and HCP populations, and setting are direct. Two studies[24,25] (N = 601 residents and their HCP) conducted in nursing care facilities (VA and community) reported on MRSA contamination of HCP gowns and gloves after delivery of routine resident care activities. • One cohort[24] (N = 200 residents) of seven Veterans Affairs (VA) nursing care facilities sampled gowns and gloves worn by HCP during routine resident care activities over a 28-day period for residents with a history of MRSA in the prior year and reported an increase in the odds of gown and glove contamination with changing dressings (e.g. wound, j-tube), providing hygiene (e.g. brushing teeth, combing hair), and bathing (OR>1; p<0.05). There was an increase in the odds of glove contamination with transferring a resident, and an increase in the odds of gown contamination with dressing the resident (OR>1; p<0.05). There was a decrease in the odds of gown and glove contamination with giving medications, and a decrease in the odds of glove contamination with feeding (OR<1, p<0.05). Resident characteristics associated with increased gown contamination included the presence of wounds (OR: 2.9; p<0.01). The incidence of glove contamination was higher than gown contamination (20% vs. 11%; p<0.01). MRSA colonization prevalence among residents was 46% (94/200). This study did not conduct power calculations or adjust for confounding factors including HCP delivering care, delivery of multiple care tasks simultaneously, or HCP-to-resident ratios, decreasing confidence in these findings. • One cohort[25] (N = 401 residents) of 13 nursing facilities sampled gowns and gloves worn by HCP during routine resident care activities and reported an increase in the odds of both gown and glove contamination with dressing a resident, providing hygiene (e.g. brushing teeth, combing hair), changing a resident's diaper, and changing linens (OR >1; p<0.05). An increase in the odds of gown contamination was associated with transferring a resident (OR >1; p<0.05). There was a decrease in the odds of gown and glove contamination associated with only delivering a medication (OR<1; p<0.05). There was a higher rate of gown and glove contamination among residents with chronic skin breakdown during transferring residents (p=0.02), changing diapers (p=0.02), and dressing (p=0.05). The incidence of glove contamination was higher than gown contamination

Outcome	Results
	(24% vs. 14%; p<0.01). MRSA colonization prevalence among residents was 28% (113/401). This study did not conduct power calculations or adjust for confounding factors beyond resident skin integrity, decreasing confidence in these findings.
RGNB contamination of HCP PPE	Two studies[22,23] (N = 584 residents) conducted in community nursing facilities suggest an increase in the odds of in resistant gram negative bacteria (RGNB) contamination of gloves. The evidence is insufficient to determine an association between resident characteristics such as presence of wounds or devices, and other care delivery actives such as transfers, dressing changes, and diaper changes. • Strength of evidence: Both studies are at risk of confounding by the HCP delivering care, delivery of multiple care tasks simultaneously, or HCP-to-resident ratios; and neither study conducted power calculations. • Consistency of evidence: The evidence is consistent for gloves during bathing, and inconsistent for other activities • Precision of evidence: Precision of the evidence is low, neither study conducted power calculations or reported confidence intervals • Directness of evidence: The resident and HCP populations, and setting are direct Two studies[22,23] (N = 584 residents and their HCP) conducted in community nursing care facilities reported on RGNB contamination of HCP gowns and gloves after delivery of routine resident care activities. • One cohort[22] (N = 399 residents) of 13 nursing facilities sampled gowns and gloves worn by HCP during routine resident care activities and reported an increase in the odds of both gown and glove contamination with showering a resident (OR>1; p<0.05). An increase in the odds of gown contamination was associated with transferring a resident and toilet assistance (OR>1; p<0.05), while an increase in the odds of glove contamination was associated with dressing changes, bathing, and diaper change (OR>1, p<0.05). There was a decrease in the odds of glove contamination associated with delivering a medication and giving any therapy (OR<1; p<0.05). There was an association between gown contamination and care delivered to residents with pressure ulcers compared to those without (OR=3.3, 95% CI 1.0–11.1); and this increased odds was reported for showering, hygiene assistance, and transferring the resident (OR>1; p<0.05). There was no association between gown or glove contamination and residents who were on systemic antibiotics at enrollment. The incidence of glove contamination was higher than gown contamination (9% vs. 3%; p=NR), and there was no transmission to gowns during dressing changes, feeding, taking surveillance cultures, delivery of medications, and glucose monitoring while there was no transmission to gloves during glucose monitoring. RGNB colonization prevalence among residents was 19% (74/399). This study did not conduct power calculations or adjust for confounding factors, decreasing confidence in these findings. • One cohort[23] (N = 185 residents) of seven Veterans Affairs (VA) nursing care facilities sampled gowns and gloves worn by HCP during routine resident care activities and reported an increase in the odds of RGNB contamination of gowns and gloves from bathing a resident and providing hygiene (e.g. brushing teeth, combing hair) (OR>1; p<0.05). An increase in the odds of glove contamination was associated with toilet assistance and the care or use of any device for a resident, while an increase in the odds of gown contamination was associated with diaper change (OR>1; p<0.05). There was a decrease in the odds of glove contamination associated with delivering medication (OR<1; p<0.05). There were higher odds of gown and glove contamination among residents who were on any type of antibiotics at enrollment (OR>1, p<0.05). The incidence of glove contamination was higher than gown contamination (7% vs. 2%; p=NR). RGNB colonization prevalence among residents was

Outcome	Results
	31% (57/185). This study did not conduct power calculations or adjust for confounding factors beyond resident skin integrity, decreasing confidence in these findings.

C.2. Extracted Evidence Relevant to of Targeted Gown and Glove Use by HCP

Table 6. The Extracted Evidence On Targeted Gown and Glove Use

Study	Population and setting	Intervention	Definitions	Results
Author: Lydecker[21] **Year:** 2020 **Data extractor:** DJT **Reviewer:** CNS/ECS **Study design:** Before-after **Study objective:** To test the feasibility of targeted gown and glove use to prevent *S. aureus* acquisition in short-stay residents of community-based nursing homes. **IVA score:** 23 (moderate) *Confounding:* HCP-to-resident ratios, and resident characteristics including type of wound, or type of device. *Measurement*: Unclear if adequately powered to detect a result, No compliance reported for comparator arm	**Population:** N = NR HCP N = 221 residents **Setting:** Two independently functioning community-based nursing homes specializing in post-acute care, skilled nursing, and rehabilitation. **Location:** Maryland, USA **Study dates:** December 2017 – July 2018 **Matching:** None **Inclusion criteria:** Adult residents living in one of the two nursing homes during study period. **Exclusion criteria:** Residents identified by staff as agitated or combative. Residents who declined or were discharged or moved to a non-study unit prior to be approached about the study.	**Intervention group:** n = 120 • **Intervention:** Residents during 2-month intervention period. Targeted gown and glove use when performing higher-risk care activities for higher-risk residents, defined as those with 1) wound(s) which required a dressing or 2) medical devices (eg urinary catheters, vascular catheters or feeding tubes). Higher risk care activities included dressing, bathing, transferring, providing hygiene, changing linens, changing brief or diaper, medical device care or use, and dressing wounds. • **Compliance:** Observation form used to capture number of gowns and gloves used. • **Implementation Strategies:** HCPs were trained on the identification of higher-risk residents and usage of gowns, gloves, caddies, and signage through presentations. Instructional flyer was distributed and posted in high-visibility staff areas for reference. **Control group:** n = 101 **Control/ Comparator:** Residents during 2-month baseline period. Standard precautions (eg gown and glove use for anticipated contact with blood, body fluids, skin breakdown, or mucous membranes) for residents with MRSA colonization	**Outcome definitions:** *S. aureus, MRSA, MSSA incidence:* A new positive culture in a short-stay resident who was negative at the start of the study period or on admission. *Resident to resident S. aureus transmission:* S. aureus isolate from each acquisition in short-stay residents matched within 30 single-nucleotide variants to another epidemiologically linked (same floor, same study period) S. aureus isolate **Colonization ascertainment:** *S. aureus* screening of residents at the start of the study period/ on admission and again at the end of the study period/ on discharge. **Sampling methods:** Swab cultures from the anterior nares and inguinal fold **Diagnostic tests:** Cultures; WGS was used to determine relatedness of isolates for resident-to-resident transmission. **Comments:** None	**Infection Outcomes:** *OR: Odds ratio* *S. aureus:* • OR: 0.35 (95% CI: 0.15-0.86), p = 0.02 • Intervention: 8/120 (6.7%) • Control: 17/101 (16.8%) *MRSA:* • OR: 0.28 (95% CI: 0.08 - 0.92), p = 0.026 • Intervention: 4/111 (3.6%) • Control: 10/84 (11.9%) *MSSA:* • OR: 0.41 (95% CI: 0.12 - 1.42), p = 0.15 • Intervention: 4/101 (4.0%) • Control: 8/88 (9.1%) *Resident-to-resident S. aureus transmission:* • OR: 0.13 (95% CI: 0.02 - 1.12), p = 0.06 • Intervention: 1/120 (0.8%) • Control: 6/101 (5.9%) **Other related outcomes:** Increase in gown use during higher-risk care activities from 0% before the intervention to 78% after the intervention for higher-risk residents. 97% of higher-risk residents were correctly identified for targeted gown and glove use. **Adverse events:** NA **Cost outcomes:** NA

Study	Population and setting	Intervention	Definitions	Results
(standard precautions)		• **Compliance:** Observation form used to capture number of gowns and gloves use. **Exposure assignment or ascertainment:** Exposure assignment was based on when they were admitted into one of the two facilities. **Standard preventive measures:** Each nursing home has an educator responsible for monitoring and training staff on infection prevention practices. *S. aureus* screening at the start of the study period/ on admission and again at the end of the study period/ on discharge.		

Table 7. The Extracted Evidence for Studies Reporting Contaminated HCP PPE

Study	Population and setting	Exposure	Definitions	Results
Author: Blanco[23] **Year:** 2017 **Data extractor:** MM **Reviewer:** CNS/ECS **Study design:** Cohort **Study objective:** To examine care-specific transmission of resistant gram-negative bacteria (RGNB) to HCP gowns and gloves, and to identify resident characteristics associated with transmission of RGNB. **IVA score:** 20 (Moderate)	**Population:** N = NR HCP N = 185 residents N = 1,062 HCP interactions Facility stratified perianal colonization rates of residents: • A: 13.3% • B: 7.7% • C: 57.1% • D: 33.3% • E: 78.8% • p<0.01 **Setting:** Seven Veterans Affairs (VA) nursing homes aggregated by location **Location:** Maryland, Massachusetts, New York,	**Exposed:** n = 905 HCP-resident interactions • **Exposure:** n = 57 RGNB+ residents • **Pathogen:** RGNB **Comparator:** n = 157 HCP-resident interactions • **Exposure:** N = 128 RGNB- residents (n = 11 residents analyzed) **Exposure ascertainment:** Residents were considered RGNB colonized if the perianal culture was positive for at least one RGNB. **Standard preventive measures:** *Gowns and gloves:* All sites implemented the use of gowns and gloves. For up to 28 days after a resident enrolled, HCP were asked to wear gowns and gloves during usual care activities. A research coordinator observed and recorded the type of care delivered with each interaction.	**Outcome definitions:** *RGNB contamination of gowns and gloves:* Deemed to occur when at least one strain isolated from the HCP gowns or gloves matched the genus, species, and antibiotic resistance pattern of the strain isolated from the respective RGNB-colonized resident. RGNB includes any pathogenic Gram-negative bacteria categorized as intermediate or resistant for at least one of the following antibiotics: ciprofloxacin, ceftazidime, or imipenem. *RGNB contamination by resident care activity:* Deemed to occur when at least one strain isolated from the HCP gowns or gloves matched the genus, species, and antibiotic resistance pattern of the	**Contamination outcomes:** *OR: Odds ratio; calculated using GEE to account for the correlation of repeated measurements obtained from a given resident* *RGNB contamination of gowns and gloves:* • Gloves or gowns: 9% • Gloves only: 7% • Gowns only: 2% *RGNB contamination by resident care activity:* Bathing Interactions • Gloves OR: 5.60, p < 0.01 • Gowns OR: 10.05, p < 0.01 • n = 71 interactions • Care given with other care: 83% Toilet assistance • Gloves OR: 2.46, p = 0.01 • Gowns OR: 0.76, p = 0.83 • n = 56 interactions • Care given with other care: 80% Hygiene

Study	Population and setting	Exposure	Definitions	Results
Confounding: HCP-to-resident ratios, delivery of other care tasks, and resident characteristics including type of wound, or type of device. *Measurement*: Unclear if adequately powered to detect a result, and no confidence intervals were reported	Texas, and Washington D.C., USA **Study dates:** 2012 —2015 **Matching:** NA **Inclusion criteria:** Swabs of gloves and gowns worn by HCP during resident care activities for RGNB+ and RGNB- residents. **Exclusion criteria:** NR		strain isolated from the respective RGNB-colonized resident, with types of care stratified by care that occurred with other care activities and care that occurred alone *Contamination via RGNB(-) residents:* Contamination of gloves and/or gown by residents who were not found to be colonized by RGNB in the perianal culture but which resulted in HCP interactions that were positive for RGNB *Antibiotic use:* Contamination of gloves and gowns stratified by Reported use of antibiotics by nursing home resident recorded at enrollment **Contamination ascertainment:** Perianal swabs were obtained from enrolled residents at baseline. After HCP-resident interactions during care activities, gloves and gowns were swabbed. Contamination of gowns and/or gloves with RGNB occurred when at least one strain isolated from the HCP gowns or gloves matched the genus, species, and antibiotic resistance pattern of the strain isolated from the respective RGNB-colonized resident **Sampling methods:** Swabs of HCP gloves and gowns in a standardized manner after resident care activities **Diagnostic tests:** Cultures using MacConkey agar supplemented with 1g/ml of ciprofloxacin, MacConkey agar supplemented with 1g/ml of ceftazidime, and MacConkey agar supplemented with 1g/ml of imipenem. Plates	• Gloves OR: 2.22, p = 0.02 • Gowns OR: 7.17, p < 0.01 • n = 111 interactions • Care given with other care: 87% Any device care or use • Gloves OR: 1.87, p = 0.04 • Gowns OR: 0.45, p = 0.60 • n = 86 interactions • Care given with other care: 56% Physical exam • Gloves OR: 1.75, p = 0.05 • Gowns OR: 1.10, p = 0.89 • n = 95 interactions • Care given with other care: 32% Transfer of resident • Gloves OR: 1.55, p = 0.19 • Gowns OR: 2.35, p = 0.14 • n = 168 • Care given with other care: 72% Diaper change • Gloves OR: 1.48, p = 0.20 • Gowns OR: 0.76, p = 0.03 • n = 145 • Care given with other care: 82% Dressing change • Gloves OR: 1.46, p = 0.25 • Gowns OR: 0.49, p = 0.50 • n = 86 • Care given with other care: 42% Dressing resident • Gloves OR: 1.37, p = 0.37 • Gowns OR: 2.27, p = 0.25 • n = 137 • Care given with other care: 91% Changing linens • Gloves OR: 1.26, p = 0.41 • Gowns OR: 0.25, p = 0.23 • n = 139

Study	Population and setting	Exposure	Definitions	Results
			were streaked for isolation and incubated aerobically at 37°C for 24 h. Kirby-Bauer test used to determine susceptibility. **Comments:** None	• Care given with other care: 42% Feeding • Gloves OR: 0.65, p = 0.74 • Gowns: No contamination • n = 23 • Care given with other care: 26% Any therapy • Gloves OR: 0.51, p = 0.73 • Gowns: No contamination • n = 16 • Care given with other care: 6% Any medications • Gloves OR: 0.29, p < 0.01 • Gowns: No contamination • n = 279 • Care given with other care: 19% Any medication alone • Gloves OR: 0.12, p < 0.01 • Gowns: No contamination • n = 227 • Care given with other care: 0% Feeding alone • Gloves: No contamination • Gowns: No contamination • n = 17 • Care given with other care: 0% Glucose monitoring • Gloves: No contamination • Gowns: No contamination • n = 36 • Care given with other care: 78% **Other related outcomes:** *Contamination via RGNB(-) residents* • RGNB contamination: 4/157 (36%) interactions • Gloves: 6/157 (4%) • Gowns: 5/157 (3%) *Antibiotic use:*

Study	Population and setting	Exposure	Definitions	Results
				Any: • Gloves OR: 2.51, p = 0.02 • Gowns OR: 10.15, p < 0.01 Topical: • Gloves OR: 2.82, p = 0.02 • Gowns OR: 3.41, p = 0.07 Systemic: • Gloves OR: 1.54, p = 0.42 • Gowns OR: 7.89, p < 0.01 **Adverse events:** NR **Cost outcomes:** NR
Author: Blanco[22] **Year:** 2018 **Data extractor:** AH **Reviewer:** ECS/CNS **Study design:** Cohort **Study objective:** To examine care-specific transmission of multi-drug resistant Gram-negative bacteria (*RGNB*) to HCP's gowns and gloves in community nursing homes and to identify resident characteristics associated with transmission of RGNB. **IVA score:** 21 (Moderate) *Confounding:* HCP-to-resident ratios, delivery of other care activities, and resident characteristics including type of	**Population:** N = NR HCP N = 399 residents Maryland, N = 221 residents Michigan, N = 178 residents N = 767 HCP-resident interactions *Differences in baseline population* Baseline differences in RGNB colonization were seen for race/ ethnicity, ADL scores, rehab experience, and the presence of external urinary catheters; and not for other medical devices, antibiotic use, presence of any wounds, GI and respiratory secretions, or recent acute care hospitalizations **Setting:** 13 non-VA community-based nursing facilities in Maryland (n=10) and Michigan (n=3)	**Exposed PPE:** n = 584 interactions • **Exposure:** n = 74 RGNB+ residents • **Pathogen:** RGNB **Comparator:** n = 183 interactions • **Exposure:** n = 325 RGNB- residents (n = 26 residents analyzed) **Exposure ascertainment:** Residents were considered colonized with RGNB if their perianal swab collected at baseline was positive for at least one RGNB **Standard preventive measures:** *Gowns and gloves:* All sites implemented the use of gowns and gloves worn by HCP during usual care activities	**Outcome definitions:** *RGNB contamination:* Contamination of gowns and gloves with RGNB (Enterobacteriaceae family, *Pseudomonas aeruginosa*, and *Acinetobacter baumanni*) was deemed to occur when at least one strain isolated from the HCP's gown or gloves matched the genus, specifies, and antibiotic resistance pattern of the strain isolation from the respective RGNB colonized resident; stratified by care activity. RGNB includes any pathogenic Gram-negative bacteria categorized as intermediate or resistant based on the AST for at least one of the following antibiotics: ciprofloxacin, ceftazidime, or imipenem. *RGNB contamination by resident care activity:* RGNB contamination as defined above stratified by care activity *Contamination via RGNB(-) residents:* Contamination of gloves and/or gown by 26 residents who were not found to be colonized by RGNB in the perianal culture but	**Colonization outcomes:** *OR: Odds ratio* *RGNB contamination:* • Gloves or gowns: n/584 (11%) • Gloves only: n/581 (9%) • Gowns only: n/ 584 (3%) *RGNB contamination by resident care activity:* Showering • Gloves OR: 5.7, p < 0.01 • Gown OR: 15.4, p < 0.01 • n = 18 • Care given with other care: 72% Dressing change • Gloves OR: 3.6, p = 0.01 • Gowns: No transmission • n = 5 interactions • Care given with other care: 40% Bathing • Gloves OR: 3.4, p < 0.01 • Gown OR: 2.7, p = 0.12 • n = 56 interactions • Care given with other care: 86% Hygiene assistance • Gloves OR: 2.5, p = 0.07 • Gown OR: 3.8, p = 0.08 • n = 57 interactions • Care given with other care: 96%

Study	Population and setting	Exposure	Definitions	Results
wound, or type of device. *Measurement*: Unclear if adequately powered to detect a result and no confidence intervals were reported	**Location:** Maryland and Michigan, USA **Study dates:** NR **Matching:** None **Inclusion criteria:** Eligible residents were enrolled with written informed consent from them or their legally authorized representative. HCP were enrolled with verbal consent. **Exclusion criteria:** NR		which resulted in HCP interactions that were positive for RGNB **Contamination ascertainment:** At least one strain isolated from the HCP's gown or gloves matched the genus, species, and antibiotic resistance pattern of the strain isolated from the respective RGNB colonized resident **Sampling methods:** HCP gowns and gloves were swabbed in a standardized manner before they were removed completely after each encounter with each resident. **Diagnostic tests:** Culture. Swabs were enriched by inoculating 100 µl of the E-swab liquid into 5 ml of BHI broth and incubated 24 hours at 35–37°C in ambient air. This was later cultured on agar plates, streaked, and isolated and incubated aerobically at 37°C for 24 hours. Organisms identification was confirmed using an automated bacterial identification and antibiotic susceptibility testing system. Kirby-Bauer test was used to confirm each organism's susceptibility to antibiotics. Organisms were categorized as susceptible, intermediate or resistant based on the Clinical Laboratory Standards Institute's (CLSI) breakpoints **Comments:** None	Diaper change • Gloves OR: 2.5, p = 0.02 • Gown OR: 2.7, p = 0.09 • n = 91 interactions • Care given with other care: 82% Transfer of resident • Gloves OR: 1.9, p = 0.05 • Gown OR: 3.0, p < 0.01 • n = 114 interactions • Care given with other care: 76% Feeding • Gloves OR: 1.7, p = 0.56 • Gown: No transmission • n = 19 interactions • Care given with other care: 21% Toilet assistance • Gloves OR: 1.6, p = 0.27 • Gowns OR: 3.4, p < 0.01 • n = 58 interactions • Care given with other care: 64% Dressing resident • Gloves OR: 1.5, p = 0.25 • Gowns OR: 2.5, p = 0.10 • n = 98 interactions • Care given with other care: 90% Only feeding • Gloves OR: 1.2, p = 0.89 • Gowns: No transmission • n = 15 interactions • Care given with other care: 0% Changing linens • Gloves OR: 1.1, p = 0.82 • Grown OR: 0.40, p = 0.61 • n = 66 interactions • Care given with other care: 50% Any surveillance cultures • Gloves OR: 1.1, p = 0.88

Study	Population and setting	Exposure	Definitions	Results
				• Gowns: No transmission • n = 69 interactions • Care given with other care: 3% Any device care or use • Gloves OR: 0.93, p = 0.92 • Gowns OR: 1.3, p = 0.84 • n = 17 interactions • Care given with other care: 47% Physical exam • Gloves OR: 0.82, p = 0.61 • Gowns OR: 2.0, p = 0.22 • n = 76 interactions • Care given with other care: 36% Any therapy • Gloves OR: 0.30, p < 0.01 • Gowns: No transmission • n = 87 interactions • Care given with other care: 21% Any medications • Gloves OR: 0.15, p < 0.01 • Gowns OR: 0.3, p = 0.28 • n = 104 interactions • Care given with other care: 16% Only medications • Gloves OR: 0.09, p < 0.01 • Gowns OR: 0.5, p = 0.40 • n = 87 interactions • Care given with other care: 0% Glucose monitoring • Gloves: No transmission • Gowns: No transmission • n = 11 interactions • Care given with other care: 64% **Other related outcomes:** *Contamination via RGNB(-) residents:* • RGNB contamination: 15/26 (58%) • Gloves: 23/183 (13%)

Study	Population and setting	Exposure	Definitions	Results
				• Gowns: 16/183 (9%) **Adverse events:** NR **Cost outcomes:** NR
Author: Pineles[24] **Year:** 2017 **Data extractor:** MM **Reviewer:** ECS/CNS **Study design:** Cohort **Study objective:** To estimate the frequency of methicillin-resistant Staphylococcus aureus (MRSA) transmission to gowns and gloves worn by HCP interacting with Veterans Affairs Community Living Center (VA nursing home) residents to inform MRSA prevention policies. **IVA score:** 24 (Moderate) *Confounding:* HCP-to-resident ratios, delivery of other care activities, and resident characteristics including type of wound, or type of device. *Measurement*: Unclear if adequately powered to detect a result, and no	**Population:** N = 3,008 HCP interactions N = NR HCP N = 200 residents **Setting:** 7 VA nursing homes **Location:** Maryland, New York, Massachusetts, Texas & Washington D.C., USA **Study dates:** NR; over 40 months **Matching:** NR **Inclusion criteria:** Eligible residents with an expected length of stay of at least one week and did not have behavioral problems were enrolled with written informed consent from them or their legally authorized representative. HCP providing care for VA nursing home residents with and without a history of MRSA in the year prior to screening were enrolled with verbal consent. **Exclusion criteria:** NR	**Exposed HCP:** n = 1,543 HCP-resident interactions • **Exposure:** n = 94 residents that were MRSA+ • **Pathogen:** MRSA **Comparator:** n = 1,465 HCP-resident interactions • **Exposure:** n = 106 residents that were MRSA- **Exposure ascertainment:** Residents with and without a history of MRSA by surveillance or clinical culture in the year prior to the study period were identified by reviewing MRSA surveillance results. A resident was defined as MRSA colonized if the anterior nares, perianal skin, or wound (if present) swab obtained at enrollment grew MRSA. **Standard preventive measures:** *Gowns & gloves:* Worn by HCP during usual care activities for 28 days after enrollment and when body secretions were present in care activities. HCP followed standard infection control practices for gown and glove use. A research coordinator observed and recorded the type and duration of care delivered with each activity.	**Outcome definitions:** *MRSA contamination of gloves and gowns:* Contamination of HCP gloves and gowns determined by swab of gloves and gowns and positive culture after performing care activities on a MRSA-positive resident *MRSA contamination of gloves and gown by care activity:* Contamination of HCP gowns and gloves during resident-care activities including changing dressings (including wound, jejunostomy tube), dressing the resident, providing hygiene (brushing teeth, combing hair), and bathing the resident as higher-risk activities for gown contamination, glucose monitoring, giving medications, and feeding were low-risk activities for gown contamination, changing dressings, providing hygiene, bathing, and transferring the resident were higher-risk activities for glove contamination, giving medications and feeding were low-risk activities for glove contamination *MRSA contamination via MRSA-residents:* Contamination of HCP gloves and gowns determined by swab of gloves and gowns and positive culture after performing care activities on a MRSA-negative resident **Contamination ascertainment:** When HCP were finished with care activities, the research coordinator	**Contamination outcomes:** *OR: Odds ratio* *MRSA contamination of gloves and gowns:* • Glove use: n/1,543 (20%) • Gown use: n/1,543 (11%) *MRSA contamination of gloves or gowns by care activity* Hygiene • Glove use OR: 2.53, p < 0.01 • Gown use OR: 2.01, p = 0.01 • n = 139 • Care given with other types of care: 70% Any dressing change • Glove use OR: 2.02, p = 0.01 • Gown use OR: 2.33, p < 0.01 • n = 141 • Care given with other types of care: 33% Transfer of resident • Glove use OR: 1.63, p = 0.05 • Gown use OR: 1.70, p = 0.11 • n = 164 • Care given with other types of care: 51% Bathing • Glove use OR: 1.58, p < 0.01 • Gown use OR: 2.38, p < 0.01 • n = 122 • Care given with other types of care: 59% Dressing resident • Glove use OR: 1.55, p = 0.13 • Gown use OR: 2.31, p < 0.01 • n = 119 • Care given with other types of care: 76% Any device care or use • Glove use OR: 1.54, p = 0.19 • Gown use OR: 1.68, p = 0.17

Study	Population and setting	Exposure	Definitions	Results
confidence intervals were reported			used a dual-tipped rayon flocked swab to culture the HCP's gown and gloves. **Sampling methods:** Flocked swab of gown and gloves after delivery of care activities **Diagnostic tests:** Cultures **Comments:** This population is the same as Blanco 2017.	• n = 90 • Care given with other types of care: 48% Diaper change • Glove use OR: 1.43, p = 0.07 • Gown use OR: 1.42, p = 0.25 • n = 127 • Care given with other types of care: 68% Glucose monitoring • Glove use OR: 0.92, p = 0.79 • Gown use OR: 0.74, p = 0.34 • n = 38 • Care given with other types of care: 47% Glucose monitoring alone • Glove use OR: 0.66, p = 0.56 • Gown use OR: No transmission • n = 20 • Care given with other types of care: 0% Any therapy • Glove use OR: 0.83, p = 0.64 • Gown use OR: 0.80, p = 0.64 • n = 33 • Care given with other types of care: 6% Physical examination • Glove use OR: 0.86, p = 0.40 • Gown use OR: 1.04, p = 0.88 • n = 177 • Care given with other types of care: 18% Toilet assist • Glove use OR: 0.73, p = 0.22 • Gown use OR: 1.06, p = 0.82 • n = 83 • Care given with other types of care: 58% Any medications • Glove use OR: 0.66, p <0.05 • Gown use OR: 0.59, p <0.05 • n = 384 • Care given with other types of care: 11%

Study	Population and setting	Exposure	Definitions	Results
				Any medications alone • Glove use OR: 0.65, p = 0.03 • Gown use OR: 0.53, p = < 0.01 • n = 341 • Care given with other types of care: 0% Feeding • Glove use OR: 0.49, p < 0.05 • Gown use OR: No transmission • n = 68 • Care given with other types of care: 18% Changing linens • Glove use OR: 0.41, p = 0.82 • Gown use OR: 1.17, p = 0.48 • n = 252 • Care given with other types of care: 19% **Other related outcomes:** *MRSA contamination via MRSA- residents:* • Glove use: 35/1,463 (2%) • Gown use: 21/1,462 (1%) **Adverse events:** NR **Cost outcomes:** NR
Author: Roghmann[25] **Year:** 2015 **Data extractor:** DT **Reviewer:** CNS/ECS **Study design:** Cohort **Study objective:** To estimate the risk of MRSA transmission to gowns and gloves by type of care provided during HCP–resident interactions and to estimate the costs of	**Population:** N = NR HCP N = 401 residents N = 1,104 HCP-resident interactions **Setting:** 13 non-Veterans Affairs, community-based nursing homes **Location:** Maryland and Michigan, U.S. **Study dates:** NR; residents were screened for enrollment over 25 months and HCP were asked to wear gloves and	**Exposed PPE:** n = 954 HCP-resident interactions • **Exposure:** n = 113 residents colonized with MRSA • **Pathogen:** MRSA **Comparator:** n = 150 HCP-resident interactions • **Exposure:** n = 288 residents not colonized with MRSA (n = 23 residents analyzed) **Exposure ascertainment:** Residents with MRSA colonized from anterior nares or perianal skin swabs on enrollment. **Standard preventive measures:**	**Outcome definitions:** *Contamination of gowns and gloves:* A positive culture for MRSA from the gowns and gloves of HCP conducting usual resident care activities on MRSA colonized residents stratified by type of care. *Contamination via MRSA(-) residents:* A positive culture for MRSA from the gowns and gloves of HCP conducting usual resident care activities on MRSA negative residents *Mean total variable cost:* Costs were calculated using quantity data	**Contamination outcomes:** *aOR: Adjusted odds ratio; model included clustering within individual MRSA-colonized residents* *Contamination:* Overall, n/total interactions (%) • Gowns: n/954 (14%) • Gloves: n/954 (24%) • p < 0.01 Dressing: • Gowns aOR: 2.33 (95% CI: 1.50-3.61), p < 0.01 • Gloves aOR: 1.81 (95% CI: 1.33-2.45), p < 0.01 • n = 138 interactions • Care given with other care: 91% Transfer:

Study	Population and setting	Exposure	Definitions	Results
3 MRSA transmission prevention scenarios compared with standard precautions in community-based nursing homes. **IVA score:** 18 (moderate) *Confounding:* HCP-to-resident ratios, delivery of other care activities, and resident characteristics including type of wound, or type of device. *Measurement*: Unclear if adequately powered to detect a result and confidence intervals were wide in some cases **Related article:** Roghmann 2016[26]	gowns during usual care activities up to 28 days after resident enrollment **Matching:** None **Inclusion criteria:** Eligible residents with an expected length of stay of at least one week, spoke English, and consented/assented/ or lacked dissent to study procedures were enrolled with written informed consent from them or their legally authorized representative. HCP who gave verbal consent and provided care to nursing home residents. **Exclusion criteria:** NR	*Gowns and gloves:* All sites implemented the use of gowns and gloves. HCP were asked to wear gloves and gowns during usual care activities up to 28 days after resident enrollment and HCP followed standard infection control practices for gown and glove use	regarding the units of types of care multiplied by unit cost data reflecting the unit cost associated with each type of care. The costs associated with each type of care were summed across all residents to calculate a total cost of each type of care in each subgroup in each study arm. The total monthly costs were calculated as the sum of the total costs across each type of care. Unit costs for gowns and gloves were $0.96 and $0.09, respectively. HCP costs were estimated using a time and motion approach based on recorded time in minutes for HCP to don and doff a gown and gloves (set at 1 minute) and the hourly wages of HCP (based on hourly wage data available from the Bureau of Labor Statistics). The hourly wage data represented individuals working in nursing care facilities in Maryland, reflected gross pay based on a work year of 2,080 hours and included standard employer fringe benefits: registered nurses ($30.02), nurse aides ($12.09), physical therapists ($42.74), occupational therapists ($41.71), and speech therapists ($42.95). Costs were measured nominally in 2014 dollars. **Contamination ascertainment:** HCP gowns and gloves were swabbed at the end of each resident-care activity. **Sampling methods:** Swab of gown and gloves **Diagnostic tests:** Culture	• Gowns aOR: 2.13 (95% CI: 1.44-3.13), p < 0.01 • Gloves aOR: 1.25 (95% CI: 0.90-1.72), p = 0.19 • n = 167 interactions • Care given with other care: 70% Hygiene: • Gowns aOR: 1.98 (95% CI: 1.20-3.28), p < 0.01 • Gloves aOR: 1.58 (95% CI: 1.09-2.30), p = 0.02 • n = 106 interactions • Care given with other care: 92% Change linens: • Gowns aOR: 1.84 (95% CI: 1.19-2.83), p < 0.01 • Gloves aOR: 1.77 (95% CI: 1.13-2.78), p = 0.01 • n = 129 interactions • Care given with other care: 39% Diaper: • Gowns aOR: 1.66 (95% CI: 1.02-2.72), p = 0.04 • Gloves aOR: 1.48 (95% CI: 1.05-2.09), p = 0.02 • n = 108 interactions • Care given with other care: 81% Toilet: • Gowns aOR: 1.53 (95% CI: 0.98–2.40), p = 0.06 • Gloves aOR: 1.26 (95% CI: 0.78–2.02), p = 0.35 • n = 95 interactions • Care given with other care: 66% Bathing: • Gowns aOR: 1.47 (95% CI: 0.85-2.56), p = 0.17 • Gloves aOR: 1.48 (95% CI: 0.99-2.21), p = 0.06 • n = 85 interactions • Care given with other care: 81% Any dressing change: • Gowns aOR: 1.24 (95% CI: 0.38-4.02), p = 0.72 • Gloves aOR: 1.08 (95% CI: 0.54-2.16), p = 0.83 • n = 18 interactions • Care given with other care: 50% Any device care or use: • Gowns aOR: 1.17 (95% CI: 0.54-2.52), p = 0.69 • Gloves aOR: 1.09 (95% CI: 0.59-2.02), p = 0.79 • n = 42 interactions

Study	Population and setting	Exposure	Definitions	Results
			Comments: None	• Care given with other care: 48% Shower: • Gowns aOR: 1.08 (95% CI: 0.35-3.33), p = 0.90 • Gloves aOR: 1.08 (95% CI: 0.46-2.54), p = 0.87 • n = 22 interactions • Care given with other care: 81% Physical exam: • Gowns aOR: 0.99 (95% CI: 0.59-1.66), p = 0.97 • Gloves aOR: 0.99 (95% CI: 0.67-1.47), p = 0.97 • n = 129 interactions • Care given with other care: 36% Glucose monitoring: • Gowns aOR: 0.81 (95% CI: 0.20-3.32), p = 0.77 • Gloves aOR: 0.35 (95% CI: 0.08-1.50), p = 0.16 • n = 21 interactions • Care given with other care: 48% Any medications: • Gowns aOR: 0.70 (95% CI: 0.43-1.14), p = 0.15 • Gloves aOR: 0.58 (95% CI: 0.36-0.92), p = 0.02 • n = 180 interactions • Care given with other care: 22% Any therapy: • Gowns aOR: 0.67 (95% CI: 0.35-1.29), p = 0.23 • Gloves aOR: 1.11 (95% CI: 0.74-1.66), p = 0.62 • n = 118 interactions • Care given with other care: 19% Feeding: • Gowns aOR: 0.59 (95% CI: 0.09-3.93), p = 0.58 • Gloves aOR: 0.36 (95% CI: 0.07-2.05), p = 0.25 • n = 13 interactions • Care given with other care: 15% Any medications alone: • Gowns aOR: 0.50 (95% CI: 0.27-0.92), p = 0.03 • Gloves aOR: 0.56 (95% CI: 0.33-0.95), p = 0.03 • n = 141 interactions • Care given with other care: 0% Glucose monitoring alone:

Study	Population and setting	Exposure	Definitions	Results
				• Gowns: Did not converge- zero cell • Gloves aOR: 0.52 (95% CI: 0.11-2.56), p = 0.42 • n = 11 interactions • Care given with other care: 0% **Other related outcomes:** *Contamination via MRSA(-) residents:* • Gowns: 8/150 (5%) • Gloves: 8/150 (5%) **Adverse events:** NR **Cost outcomes:** *Mean total variable cost over 28 days per resident (SD):* Standard precautions: • Total: $100 ($77) ○ Gown and glove use only: $76 ○ Time to don and doff only: $24 Gown and gloves for higher-risk care for MRSA-colonized residents and standard precautions for all residents: • Total (MRSA and non-MRSA colonized): $137 ($120) ○ Gown and glove use only: $107 ○ Time to don and doff only: $30 • MRSA colonized total: $257 ($133) ○ Gown and glove use only: $205 ○ Time to don and doff only: $52 • Non-MRSA colonized total: $90 ($73) ○ Gown and glove use only: $68 ○ Time to don and doff only: $22 Gown and gloves for higher-risk care for chronic skin breakdown and standard precautions for all residents: • Total: $125 ($109) ○ Gown and glove use only: $97 ○ Time to don and doff only: $28 • Chronic skin breakdown total: $271 ($127) ○ Gown and glove use only: $210 ○ Time to don and doff only: $61 • No chronic skin breakdown total: $93 ($73) ○ Gown and glove use only: $72 ○ Time to don and doff only: $21 Gown and gloves for higher-risk care and standard precautions for all residents: • Total: $223 ($127) ○ Gown and glove use only: $179 ○ Time to don and doff only: $44

Study	Population and setting	Exposure	Definitions	Results
				There is an additional fixed cost of $5.53 per resident assuming 100% testing for MRSA.

D. Internal Validity Assessment (IVA) Signaling Prompts

- Study Design
    - Design appropriate to research question
    - Well described population
    - Well described setting
    - Well described intervention/ exposure
    - Well described control/ comparator
    - Well described outcome
    - Clear timeline of exposures/ interventions and outcomes
- Selection Bias: Sampling
    - Randomization appropriately performed
    - Allocation adequately concealed
    - Population sampling appropriate to study design
- Selection Bias: Attrition
    - Attrition not significantly different between groups
    - Attrition <10-15% of population
    - Attrition appropriately analyzed
- Information Bias: Measurement and Misclassification
    - Measure of intervention/ exposure is valid
    - Measure of outcome is valid
    - Fidelity to intervention is measured
    - Fidelity to intervention is valid
    - Prospective study
    - Adequately powered to detect result
    - Outcome assessor blinded
- Information Bias: Performance and Detection
    - Study participant blinded

    - Investigator/ data analyst blinded
    - Data collection methods described in sufficient detail
    - Data collection methods appropriate
    - Sufficient follow up to detect outcome
- Information Bias: Analytic
    - Appropriate statistical analyses for collected data
    - Appropriate statistical analyses are conducted correctly
    - Confidence interval is narrow
- Confounding
    - Potential confounders identified
    - Adjustment for confounders in study design phase
    - Adjustment for confounders in data analysis phase
    - All pre-specified outcomes are adequately reported
- Other Sources of Bias (including historical events, etc.)
    - No other sources of bias
- Conflict of Interest (COI)
    - Funding sources disclosed and no obvious conflict of interest

E. Table of Acronyms

Acronym	Expansion
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
COI	Conflict of interest
EBP	Enhanced barrier precautions
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HCP	Healthcare personnel
HICPAC	Healthcare Infection Control Practices Advisory Committee
IPC	Infection prevention and control
IVA	Internal validity assessment
LTCF	Long-term care facility
MDRO	Multidrug resistant organism
MRSA	Methicillin-resistant *Staphylococcus aureus*
MSSA	Methicillin-sensitive *Staphylococcus aureus*
NA	Not applicable
NIOSH	National Institute of Occupational Safety and Health
NR	Not reported
OR	Odds ratio
PPE	Personal protective equipment
RGNB	Resistant gram negative bacteria
S. aureus	*Staphylococcus aureus*
SD	Standard deviation
TBP	Transmission based precautions
VA	The Department of Veterans Affairs
VRI	Viral respiratory infection

F. References

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