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NIPH
Norwegian Institute of Public Health

**Report**

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# Table of contents

# Sammendrag

**Bakgrunn og formål**
Enterokokker, som finnes naturlig i tarmen, kan i stor grad være resistente mot antibiotika. Selv om enterokokkene sjelden forårsaker sykdom, utgjør bakteriene en høyere risiko for pasienter med nedsatt immunforsvar. Vankomycinresistente enterokokker (VRE), linezolidresistente enterokokker (LRE) og linezolid- og vankomycinresistente enterokokker (LVRE) utgjør en særlig utfordring og er et fokusområde for infeksjonsforebygging. VRE, spesielt *Enterococcus faecium* (VREfm), er på fremmarsj i Europa og er oppført på WHO sin "priority pathogen list" på grunn av sin resistentsevne. Det finnes ikke eradikasjonsbehandling for enterokokkbærerskap. VRE er meldingspliktig i Norge, mens det i Danmark er frivillig å sende inn isolater til referanselaboratoriet for overvåking. De nasjonale anbefalingene for forebygging ble oppdatert i 2015 i Norge og i 2016 i Danmark. I 2023 besluttet Folkehelseinstituttet (FHI) og Statens Serum Institut (SSI) å samarbeide om forslag til nye nasjonale anbefalinger for screening, målrettet mot resistente mikrober og sopp av spesiell betydning for helsetjenesten. Vi gjennomførte litteraturgjennomganger for å oppdatere anbefalingene for screening i helsetjenesten. Denne litteraturgjennomgangen er en del av en serie gjennomganger som har som mål å frembringe evidens for å støtte denne prosessen.

**Metode**
Vi søkte systematisk i fem databaser etter systematiske oversikter og primærlitteratur fra de nordiske landene og Nederland. Inklusjonskriteriene inkluderte varighet av kolonisering, smitterisiko, forekomst av resistente enterokokker i ulike pasientpopulasjoner og i ulike miljøer, eller individuelle faktorer knyttet til kolonisering eller infeksjon med resistente enterokokker. Vi ekskluderte studier om behandling, håndtering, laboratoriemetoder, legemiddelresistens og miljøscreening. Vi valgte å ikke inkludere en diskusjonsdel i denne rapporten, ettersom tolkningen av resultatene vil bli tatt opp i en mer omfattende vurdering, som vil inkludere alle kunnskapsoppsummeringene.

**Resultater**
I søket fant vi 14 studier som var relevante, alle omhandlende VRE og ingen om LRE. Det er utfordrende å vurdere varighet av kolonisering og langvarig bærerskap basert på de identifiserte studiene, men det synes å være en tendens til at vedvarende kolonisering avtar over tid. Studier om risiko for infeksjon/kolonisering med VRE etter eksponering for en infisert/kolonisert person på samme rom og eksponering for rom som tidligere har vært brukt av infiserte/koloniserte pasienter, er ikke entydige. En slik eksponering kan øke risikoen for smitteoverføring, men dokumentasjonen er sparsom. Studier av prevalensen av VRE i ulike pasientpopulasjoner fokuserer hovedsakelig på sammenslåtte prevalenser av pasienter fra ulike steder i verden, og resultatene bør tolkes med varsomhet. Denne narrative syntesen fant klare holdepunkter for at tidligere antibiotikabruk, spesielt vankomycin, var en risikofaktor for VRE-kolonisering eller -infeksjon. Andre assosierte faktorer var nylig sykehusinnleggelse, opphold på intensivavdeling, invasivt utstyr, sår og inkontinens.

**Konklusjon**
Denne oversikten viste at vedvarende VRE-kolonisering kan avta over tid. Dokumentasjonen om smitterisiko er fortsatt ikke entydig. Viktige assosierte faktorer for VRE-kolonisering omfatter tidligere bruk av antibiotika, særlig vankomycin, samt sykehusinnleggelse, opphold på intensivavdeling, invasivt utstyr, sår og inkontinens.

# Summary

**Background and aim**

Enterococci, naturally found in the gut, can be largely resistant to antibiotics. While the enterococci rarely cause disease, the bacteria pose a higher risk to immunocompromised patients. Vancomycin resistant enterococci (VRE), linezolid resistant enterococci (LRE) and linezolid-and vancomycin resistant enterococci (LVRE) are particularly challenging and a focus for infection prevention. VRE, especially *Enterococcus faecium* (VREfm), is rising in Europe and listed by WHO as a priority pathogen due to its resistant capabilities. Currently, it is not possible to clear enterococcal carriage. VRE is notifiable in Norway, and it is voluntary to send isolates to the reference laboratory for surveillance in Denmark. National prevention guidelines were updated in 2015 and 2016, in Norway and Denmark respectively. In 2023, the Norwegian Institute of Public Health (NIPH) and the Statens Serum Institut (SSI) decided to collaborate on proposals for new national recommendations for screening, targeting resistant microbes of special significance to healthcare. We conducted literature reviews to update screening recommendations for resistant microbes in healthcare. This literature review is part of a series of reviews aimed at providing evidence to support this process.

**Methods**

We systematically searched five databases for systematic reviews and primary literature from the Nordic countries and the Netherlands. Inclusion criteria included whether outcomes were duration of colonisation, risk of transmission, prevalence of resistant enterococci among different patient populations and in different settings, or individual factors associated with resistant enterococci colonisation or infection. We excluded studies on treatment, management, laboratory methods, drug resistance, and environmental screening. We chose not to include a discussion section in this report, as the interpretation of the results will be addressed in a more comprehensive assessment, which will incorporate all evidence syntheses along with other considerations.

**Results**

In our search, we found 14 studies to be relevant. All studies involved VRE, and no studies on LRE were identified. Assessments of duration of colonisation and long-time carriage remain challenging based on identified studies, but there might be a trend that that persistent colonization decreases over time. Studies on risk of infection/colonisation with VRE after exposure to an infected/colonised roommate and rooms previously occupied by infected/colonised patients are inconclusive. The exposure may increase the risk of transmission, but the evidence is scarce. Studies on the prevalence of VRE in different patient populations mainly focuses on pooled prevalences of patients from different settings in the world, and interpretation of the results should be done with caution. This narrative synthesis found clear evidence that previous antibiotic use, especially vancomycin, was a risk factor for VRE colonisation or infection. Other associated factors were recent hospitalisation, ICU stay, invasive devices, wounds, and incontinence.

**Conclusion**

This review showed that persistent VRE colonisation may decrease over time. Evidence on transmission risks remains inconclusive. Key risk factors include prior antibiotic use, especially vancomycin, as well as hospitalisation, ICU stay, invasive devices, wounds, and incontinence.

# Background

Enterococci are bacteria that occur naturally in the gut and can be widely resistant to different types of antibiotics. Carriage can be long-term and it is currently not possible to clear the bacteria from the gut with treatment. However, enterococci rarely cause disease but patients with weakened immune systems may be at risk of getting an enterococcal infection, which can be severe. Resistant enterococci are not necessarily more virulent than other enterococci, but successful treatment is more difficult. Vancomycin resistant enterococci (VRE), linezolid resistant enterococci (LRE) and linezolid and vancomycin resistant enterococci (LVRE) are bacteria that require special focus in the context of infection prevention and control (IPC) measures in the health service. Of these, VRE is the most widespread, and there is a great concern about the significant increase in vancomycin resistant *Enterococcus faecium* (VREfm) in Europe (1). VREfm is also included in WHO Bacterial Priority Pathogens List (2024) due to its ability to transfer mobile genetic elements encoding resistance across One Health interfaces (2).

In Denmark, resistant enterococci are not notifiable. However, since 2005, Danish clinical microbiology departments have voluntarily submitted clinical isolates with VRE and/or vancomycin-variable enterococci (VVE) to the Reference Laboratory for Antibiotic Resistance at Statens Serum Institut for species identification, genotyping and monitoring. VRE has been notifiable in Norway since 1995 (infections, 2005 infections and carriage). National guidelines to prevent the spread of VRE was last updated in 2016 and 2015 in the two countries respectively. The national screening recommendations have many similarities, but also some minor differences. In 2023, the Norwegian Institute of Public Health (NIPH) and Statens Serum Institut (SSI) entered into an agreement to collaborate on proposals for new national recommendations for screening targeting resistant microbes of special significance to healthcare. We conducted literature reviews on key research questions for methicillin-resistant staphylococcus aureus (MRSA), resistant enterococci (vancomycin-resistant enterococci (VRE), linezolid-resistant enterococci (LRE) and linezolid-and vancomycin-resistant enterococci (LVRE)), Gram-negative bacteria producing extended spectrum betalactamase (ESBL), including carbapenemase (CPO), and *Candida auris* (*C. auris*) in order to update outdated recommendations, and investigate opportunities to approach similar recommendations both for the different microbes and in the two countries.

This report is part of a series of narrative syntheses of current evidence for the selected microbes. The working group defined outcomes of interest in advance, which were formulated in a research question. As can be seen from the methodology chapter, we started with a broad literature search where we reviewed the systematic reviews (step 1). We then wanted to narrow down the search in order to find relevant primary literature in a more targeted manner, and then only included studies conducted in the Nordic countries and the Netherlands, as these are transferable to Danish and Norwegian conditions (step 2).

Our aim with the literature review was to find evidence for key factors that are important when designing a targeted screening programme, to form a basis for decision-making when updating screening recommendations in Norway and Denmark.

# Methods

## Literature search

**Step 1**

A comprehensive systematic literature search was conducted in the beginning of December 2023, in Medline (via Ovid), Embase (via Ovid), Cochrane Database of Systematic Reviews/Cochrane Central Register of Controlled Trials, Web of Science, and Epistemonikos. The searches were performed by a specialist librarian (RAT) at the Library for the Healthcare Administration, Norwegian Institute of Public Health, Oslo, Norway, following an internal peer review by another librarian from the same library.

Search terms for VRE/LRE/LVRE combined with synonyms using appropriate truncations and abbreviations, were used to search titles, abstracts, author keywords, and controlled vocabulary. A filter for systematic reviews was applied to refine the results. The search strategy was tailored to each database's search interface and limited to the years 2009 to the present. The complete search strategies can be found in the Appendix 1.

**Step 2**

An additional search was conducted on September 2, 2024, in Medline (via Ovid), Embase (via Ovid), Cochrane Database of Systematic Reviews/Cochrane Central Register of Controlled Trials, and Web of Science. Search terms for VRE/LRE/LVRE, combined with terms for colonization including synonyms with appropriate truncations and abbreviations, were used to search titles, abstracts, author keywords, and controlled vocabulary. A filter for the Nordic countries and the Netherlands was added, and the results were limited to the years 2012 to the present.

All identified records were added, sorted, screened for duplicates (using different combinations of fields in preferences), and organised in the EndNote 20 software by Clarivate Analytics, Web of Science™.

**Research questions**

Our research question was:
…What is
the duration of colonisation,
risk of transmission,
prevalence among different patient populations and in different settings, and
individual factors associated with colonisation/infection
…of resistant enterococci (VRE/LRE/LVRE)?

*Table 1. Inclusion criteria*

| PICO | |
|---|---|
| **Population** | Individuals tested/screened for resistant enterococci (VRE/LRE/LVRE) |
| **Outcome** | Either of…<br>1. Duration of colonization with resistant enterococci (VRE/LRE/LVRE)<br>2. Risk of transmission with resistant enterococci (VRE/LRE/LVRE)<br>3. Prevalence of resistant enterococci (VRE/LRE/LVRE) among different patient populations and in different settings<br>4. Factors associated with resistant enterococci (VRE/LRE/LVRE) infection or colonisation |
| **Study design** | **Step 1:** Systematic reviews and scoping reviews (systematic search and inclusion criteria)<br>**Step 2:** Interventional or observational studies from the Nordic countries and the Netherlands |
| **Year of publications** | **Step 1:** 2009- present<br>**Step 2:** 2012-present |
| **Country/context** | **Step 1:** No filter<br>**Step 2**: The Nordic countries and the Netherlands |
| **Language** | **Step 1:** English, Norwegian, Swedish, Danish, German<br>**Step 2**: No filter |

**Exclusion criteria:**

- Studies on treatment outcomes
- Studies on management of cases with resistant enterococci
- Studies on laboratory methods (including sampling methods) for detection of resistant enterococci
- Studies investigating levels of drug resistance
- Studies concerning genetically related resistant enterococci or cell biology
- Studies exclusively concerning environmental screening, nor studies regarding sampling in the environment during outbreaks
- Studies on preventive measures (including screening) against postoperative wound infections
- **Step 1:** Narrative reviews, primary studies, letter to the editor, abstracts/posters, non peer-reviewed studies, correspondence, short communications, comments
- **Step 2:** Letter to the editor, abstracts/posters, non peer-reviewed studies/reports, correspondence, short communications, comments
- Outcomes not reported for resistant enterococci specifically

## Study selection

We used EPPI-reviewer as a screening tool (3). Upon removing duplicates, three researchers (LEØ, RR and MM) tested the inclusion and exclusion criteria on an initial sample of 50 articles using their titles and abstracts. Subsequently, two researchers (LEØ and MM) screened the remaining studies. It was planned that disagreements or uncertainties should be addressed through discussion with a third researcher acting as an arbiter (RR) but due to resource challenges this was not adhered to. Disagreements were solved by LEØ and MM. However, overall inclusion/exclusion criteria were discussed with RR in connection to the literature review of *C. auris* mentioned in the introduction. Outcomes of these discussions were also relevant for this study, although it did not address studies on resistant enterococci specifically. LEØ and MM then split the included articles amongst themselves and independently reviewed the full texts of included articles and made the final selection decisions. Remaining uncertainties regarding full-text inclusion were resolved through discussion between the researchers (LEØ and MM). An expert on review methodology (JH) provided feedback on the study selection process and methodological approach.

In this report, we use *outcome of interest* to refer to the key factors we looked for in the studies, and which are operationalised in our research question. Namely, the duration of colonisation, risk of transmission, prevalence of resistant enterococci among different patient populations and in different settings, and individual factors associated with colonisation/infection of resistant enterococci (VRE/LRE/LVRE).

In this report, we do not distinguish between intermittent and persistent carriers of resistant enterococci, and we consistently use colonisation to describe carriage in these groups.

**Data extraction**

Two researchers (LEØ, MM) extracted data points concerning the outcomes of interest. For all studies, we extracted information on the country of study, study design and reported outcome of interest.

For the systematic reviews we extracted information on search period, databases, setting/population, pathogens, study subjective, number of studies included, type of studies included, number of patients, quality assessment and authors conclusion. We believe this data is important for assessing confidence in the results and transferability to a Nordic setting.

When it comes to the primary literature from the Nordic countries and the Netherlands, we extracted data on study period, setting/population, study objective, and screening sites for all studies. In addition, we added a column with our comments on the study. We only found relevant primary studies for the two outcomes; duration of colonisation and prevalence in different settings/populations. When it comes to the duration of carrier status, we extracted data on inclusion criteria, number of patients, lost to follow-up, screening site, follow-up time, screening interval, and definition of clearance. Regarding the outcome of prevalence, we extracted data on screening type, number of screened patients, number of positive patients, and prevalence. These were regarded important parameters for the strength of the results and their importance for new screening recommendations.

## Data analysis

For each outcome, we created tables summarising the relevant studies. Each table lists the studies reporting on the specific outcomes, along with the variables relevant for the outcome. A narrative synthesis of the literature on each of our four outcome categories were then made.

## Chosen limitation in the structure of this report

We chose not to include a discussion section in this report, as the interpretation of the results will be addressed in a more comprehensive assessment, which will incorporate all evidence syntheses along with other considerations such as ethics and economics.

# Results

## Selected studies

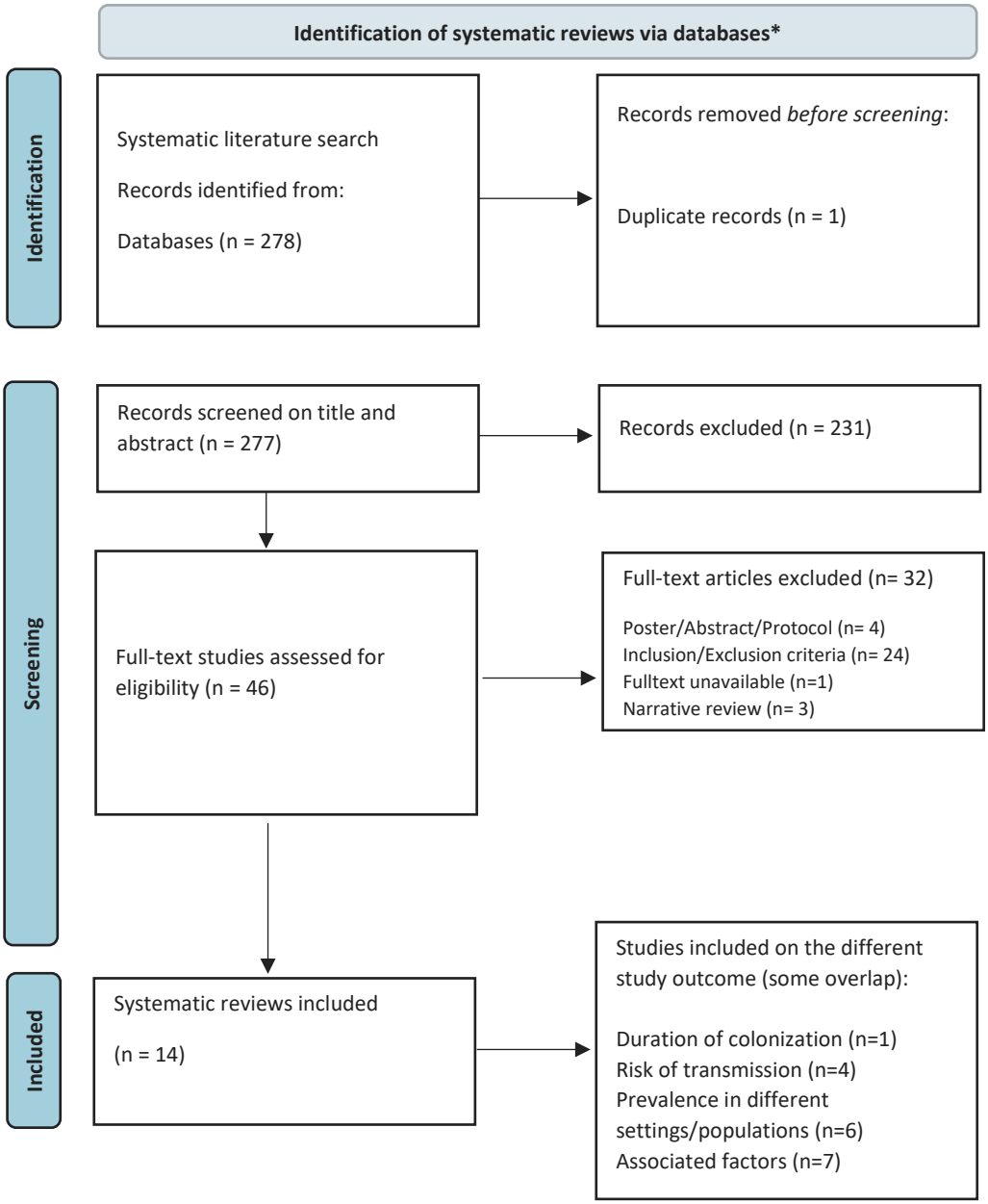
#### Systematic reviews

After removal of duplicates, we identified 277 systematic reviews (Figure 1). Upon screening titles and abstracts, we selected 46 studies. On full-text screening 32 of these studies did not meet the inclusion criteria and were excluded. A total of 14 full-text articles were included. All studies involved VRE, no studies on LRE were identified. Publication dates ranged from 2011 to 2023. Selected studies addressing our outcomes of interest was duration of colonisation (n=1), risk of transmission (n=4), prevalence in populations/settings (n=6), and associated factors (n=7).

#### Primary studies from the Nordic countries and the Netherlands

Through the literature search on studies from Iceland, Finland, Denmark, Sweden, Norway, and the Netherlands, we identified 198 primary studies. After screening titles and abstracts 12 references met the inclusion criteria. Upon full-text screening, four articles were considered relevant and included: two reported on the duration of colonisation and two reported on prevalence in different populations/settings.

An overview of the included systematic reviews and primary studies is provided in Table 2.




** Ovid Medline(R) and Epub Ahead of Print, Embase, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Web of Science and Epistemonikos.*

*Figure 1. Flow diagram of search strategy and study inclusion*

*Table 2. Overview of included studies (systematic reviews and primary studies).*

| First author (Year) | Title | Country | Study design | Outcome of interest |
|---|---|---|---|---|
| Ajao (2011) | Systematic review of measurement and adjustment for colonization pressure in studies of methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococci, and clostridium difficile acquisition | USA, Europe, Canada, Hong Kong | Systematic review | Risk of transmission, associated factors |
| Alevizakos (2017) | Colonization With Vancomycin-Resistant Enterococci and Risk for Bloodstream Infection Among Patients With Malignancy: A Systematic Review and Meta-Analysis | USA, Canada, Europe, Asia, Oseania | Systematic review and meta-analysis | Prevalence in different populations and settings, associated factors |
| Cohen (2017) | Transmission of health care-associated infections from roommates and prior room occupants: a systematic review | N/A | Systematic review | Risk of transmission |
| Danielsen (2023) | Clinical outcomes of antimicrobial resistance in cancer patients: a systematic review of multivariable models | USA, Asia, Europe | Systematic review | Associated factors |
| Flokas (2017) | Vancomycin-resistant enterococci colonisation, risk factors and risk for infection among hospitalised paediatric patients: a systematic review and meta-analysis | Asia, USA, Europe, South-America, Oceania, Africa | Systematic review and meta-analysis | Prevalence in different populations and settings, associated factors |
| Mitchell (2015) | Risk of organism acquisition from prior room occupants: a systematic review and meta-analysis | USA, Australia, France | Systematic review and meta-analysis | Risk of transmission |
| Peters (2019) | Occupational Infection Risk with Multidrug-Resistant Organisms in Health Personnel-A Systematic Review | Europe, North America, South America, Asia, Africa | Systematic review | Prevalence in different populations and settings |
| Shenoy (2014) | Natural history of colonization with methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant Enterococcus (VRE): a systematic review | Canada, Netherlands, South-Korea, USA | Systematic review | Duration of VRE-colonisation |
| Sulis (2022) | Exposure to World Health Organization's AWaRe antibiotics and isolation of multidrug resistant bacteria: a systematic review and meta-analysis | High-income-, upper middle-income countries | Systematic review and meta-analysis | Associated factors |
| Ulrich (2017) | Outbreaks caused by vancomycin-resistant Enterococcus faecium in hematology and oncology departments: A systematic review | N/A | Systematic review | Risk of transmission |
| Van Buul (2012) | Antibiotic Use and Resistance in Long Term Care Facilities | N/A | Systematic review | Associated factors |
| Zacharioudakis (2015) | Vancomycin-resistant enterococci colonization among dialysis patients: a meta-analysis of prevalence, risk factors, and significance | North America, Europe, Asia, Oceania, South America | Systematic review and meta-analysis | Prevalence in different populations and settings, associated factors |
| Ziakas (2013) | Trends and significance of VRE colonization in the ICU: a meta-analysis of published studies | US, Asia, Europe, Oceania, and S. America | Systematic review and meta-analysis | Prevalence in different populations and settings |
| Ziakas (2014) | MRSA and VRE colonization in solid organ transplantation: a meta-analysis of published studies | USA and Brazil | Systematic review and meta-analysis | Prevalence in different populations and settings |
| Knudsen (2023) | Long-term carriage and evolution of VREfmLong-term carriage and evolution of vancomycin-resistant Enterococcus faecium: a genomic study on consecutive isolates | Denmark | Primary study | Duration of VRE-colonisation |
| Rubin (2022) | No Effect of Lactobacillus rhamnosus GG on Eradication of Colonization by Vancomycin-Resistant Enterococcus faecium or Microbiome Diversity in Hospitalized Adult Patients | Denmark | Primary study | Duration of VRE-colonisation |
| Aro (2018) | High rates of meticillin-resistant Staphylococcus aureus among asylum seekers and refugees admitted to Helsinki University Hospital, 2010 to 2017 | Finland | Primary study | Prevalence in different populations and settings |
| Koole (2013) | Colonization of Libyan civil war casualties with multidrug-resistant bacteria | Netherlands | Primary study | Prevalence in different populations and settings |

## Narrative synthesis

### 1. Duration of colonization with resistant enterococci

#### Systematic reviews

One systematic review was found reporting on duration of colonization (4). The review found that persistent colonization decreases over time. The median duration of total follow-up was 25 weeks, and 50% of subjects cleared colonisation within 25 weeks after initial documentation of colonisation. According to the model by Shenoy et al, at 10, 20, 30, and 40 weeks after initial determination of VRE colonisation, it was estimated that 19, 38, 61, and 80% of subjects, respectively, had documented clearance of colonization. Most of the included subjects were hospitalised patients. The systematic review highlights the heterogeneity of studies and the challenges interpreting the median time to clearance due to factors such as inconsistent definitions of clearance, uncertainty regarding the time of initial colonisation, variation in sampling frequency of for persistent colonisation, and variation in follow-up duration and loss to follow-up.

#### Primary studies from the Nordic countries and the Netherlands

Two Danish studies investigated the duration of colonisation in vancomycin-resistant *Enterococcus faecium* (VREfm) (5, 6). Knudsen et al demonstrated that 44.2% of 206 patients carried the same clone after rescreening on admission after minimum one year. However, the study could not determine time to decolonisation since the patients were only retested on hospital admission. Rubin et al found that 60% of the 48 included patients cleared their VREfm after four weeks, and almost 90% (16/18) experienced spontaneous decolonisation after 24 weeks. We were unable to find a description of the clearance criteria in the published article, which hampers interpretation.

*Table 3. Overview of characteristicts and findings from one systematic review in the duration of VRE-colonisation.*

| First author (Year) | Country | Search period | Databases | Setting/ population | Pathogens | Study objective | No. studies incl. | Type of studies incl. | No. of patients | Quality assessment | Authors´ conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shenoy (2014)** | Canada, Netherlands, South-Korea, USA | 1990-2012 | Ovid Medline | Hospital and LTCF | MRSA and VRE | To calculate estimates of time to clearance of colonization | 13 on VRE | Cohort, RCT | 1804 | Modification of the Newcastle-Ottawa Quality Assessment Scale (NOS) developed specifically for the purposes of this review | Persistent colonization decreases over time, with clearance of colonization in half of patients at 88 weeks for MRSA and 26 weeks for VRE.<br>While the weight of the existing data, and clinical experience, suggest that clearance of MRSA and VRE colonization increases over time, precision around the time to clearance is not possible due to the major limitations of the studies in this domain |

MRSA: methicillin resistant *Stahpylococcus aureus*; VRE: vancomycin resistant enterococcus spp.

*Table 4. Overview of characteristics and findings from primary studies from the Nordic countries and the Netherlands on the duration of VRE colonisation.*

| First author (Year) | Country | Study period | Study design | Setting | Study objective | Inclusion criteria | Comment | No. of patients | Lost to follow-up | Screening site | Follow-up time | Screening interval | Clearance defined | Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Knudsen (2023)** | Denmark | 2012-2022 | Retrospective cohort | Hospital | To determine how many of our patients considered long-term VREfm carriers were true long-term carrriers, that is, still carrying the same VREfm clone for at least a 1 year period. | Patients were included in the study if they had two or more sequenced VREfm isolates a minimum of 365 days apart | VREfm isolates were identified through a labdatabase, were the first VREfm isolate per patient per year (clinical or screening sample) is routinely kept and sequenced. | 206 | N/A | N/A | N/A | N/A | N/A | 55.8% of the patients had acquired a different VREfm clone when compared with the baseline sample, and 44.2% still carried the same clone at the time of the second sample.<br>The median number of days between samples was 753.0 (IQR 546.5–1083.5) in the subgroup with clone shift, and 524.0 (IQR 428.5–699.5) in the subgroup without clone shift. The patients included in the study have only been retested on hospital readmission. Therefore, we cannot determine the time of decolonization based on these data. |
| **Rubin (2022)** | Denmark | | Multicenter, randomized, double-blind, | Hospital | To investigate whether a 4-week | VREfm patients | N/A | 81 | 33 | N/A | 24 weeks | 4, 8, 16, and 24 weeks | N/A | The authors did not find an effect of eradication of VREfm colonization by the probiotic LGG. In both groups, almost 60% |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | placeb controlled | | intervention with LGG could increase the numbers of VREfm clearers in hospitalized adult patients, as well as possible changes in the diversity of the microbiome | | | | | | | | | of the patients cleared their VREfm after 4 weeks, and by the end of the 20-week follow-up, almost 90% (16/18) had cleared their VREfm in both groups. |

VREfm: vancomycin-resistant *Enterococcus faecium*

## 2. Risk of transmission

We included four systematic reviews that reported on the risk of transmission of VRE (Table 5) (7-10). No systematic reviews were found for LRE or LVRE. The included reviews included studies from four continents, published between 2011 and 2017. All studies included in the systematic reviews were observational. The study settings were mainly hospitals, only a few included long-term care facilities (LTCFs).

**Transmission from infected or colonized roommates**

One systematic review investigated the association between exposure to infected or colonized roommates and the risk of HAI (8). In this review, Cohen et al found inconclusive results, with one study reporting a statistically significant higher risk, while another study reporting a significant lower risk.

**Transmission from previously occupied rooms by infected or colonized patients**

Cohen et al. identified one study reporting a statistically significant positive association between exposure to a room previously occupied by a VRE-positive patient and acquisition of VRE-colonisation (HR: 3.8, 95% CI: 2.0–7.4). However, other studies included in Cohen et al.'s review found no statistically significant association (8). In a sub-group analysis, Mitchell et al. found that the risk of transmission of the studied organisms (VRE, MRSA, ESBL-producing Gram-negative bacilli, *A. baumannii,* or *P. aeruginosa*) increased by 6.2% (287/4643) when patients were admitted to a room previously occupied by a patient with one of these organisms (9). The results were compared to 34,886 patients who were not admitted into a room where the previous room occupant had one of these organisms, of these 3.2% (1112/34,886) acquired the studied organism(s). The pooled acquisition odds ratio (OR) for all the organisms included in the systematic review (six studies) was 2.14 (95% CI: 1.65-2.77).

**Outbreaks**

In the systematic review by Ulrich et al, 12 articles addressed transmission mode (10). Six articles reported patient-to-patient transmission. In 5 cases transmission via the hands of health care workers was reported and in another 4 cases transmission was due to a contaminated environment. Ajao et al. measured the impact of colonisation pressure on VRE acquisition and found a significant association (7).

*Table 5. Overview of characteristics and findings of systematic and scoping reviews on risk of transmission of VRE.*

| First author (Year) | Country | Search period | Databases | Setting/ population | Pathogens | Study objective | No. studies incl. | Type of studies incl. | No. of patients | Quality assessment | Authors conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ajao (2011)** | USA, Europe, Canada, Hong Kong | → 2009 | MEDLINE | Hospital; ICU, medical ward | MRSA, VRE, C.diff | Measure and define colonization pressure and risk factors associated with MRSA, VRE and C.diff | 18 (8 on VRE) | Prospective/retrospective cohort, case-control | N/A | Definition of colonisation pressure varied between studies. Only 6 studies included colonization pressure in multivariable analysis | Colonisation pressure were significantly associated with VRE acquisition.<br><br>*Colonization pressure was broadly defined as the proportion of antibiotic-resistant-bacteria-positive patients, the proportion of antibiotic-resistant bacteria–positive patient-days, or the total number of antibiotic-resistant bacteria–positive patients or patient-days in the unit or the mean number of antibioticresistant bacteria–positive patients in the unit daily, weekly, monthly, or for the duration of the study period.* |
| **Cohen (2017)** | N/A | 1990-2014 | **PubMed** | Hospital/LTCF | All pathogens that can cause HAI | **Association between patients' exposure to infected/colonized hospital roommates or prior room occupants and their risk of infection/colonization with the same organism** | 18 (3 on VRE) | **Cohort, case–control and quasi-experimental studies** | N/A | **Checklist for Measuring Study Quality developed by Downs and Black** | **Exposure to infected or colonized roommates:** No significant associations between roommate exposure and infection with methicillin-resistant Staphylococcus aureus (MRSA), C. difficile, or Pseudomonas cepacia were identified. Results for vancomycin-resistant enterococci (VRE) were inconsistent, with Bass et al reporting a statistically significant positive association (hazard ratio [HR]: 18.8, 95% confidence interval: [5.4–66.2]) and Shorman and Al-Tawfiq reporting a statistically significant negative association (odds ratio [OR]: 0.04 [0.004–0.4])<br><br>**Exposure to rooms previously occupied by infected or colonized patient:** Effects of exposure to rooms previously occupied by patients with C. difficile, MRSA, and VRE were examined by at least two studies each. For each of these organisms, significant positive associations were reported by one article (C. difficile, HR: 2.4 [1.2–4.5];40 MRSA, OR: 1.4 [p=0.04];36 VRE, HR: 3.8 [2.0–7.4]37), with the remainder of articles finding no significant associations. |
| **Mitchell BG (2015)** | USA, Australia, France | 1984-2014 | Medline/PubMed, Cochrane and CINHAL | ICU | Acinetobacter, Escherichia coli, Klebsiella, Pseudomonas, Enterobacter, Citrobacter, Proteus, Serratia, | Determine the risk of pathogen acquisition for patients associated with prior room occupancy | 7 (3 on VRE) | Cross sectional, cohort, and case control | 4643 | Newcastle-Ottawa Scale (NOS) | **Exposure to rooms previously occupied by infected or colonized patient:** The analysis of the combined data from these studies overwhelmingly indicated an increased risk of acquisition. The sub-analysis suggested that regardless of the organisms VRE, MRSA, ESBL-producing Gram negative bacilli, A. baumannii or P. aeruginosa the risk of acquisition increases. 287/4643 (6.2%) were shown to acquire the same species of organism. In comparison, of 34,886 patients who were not admitted into a room where the prior |

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| | | | | | Enterococcus, Clostridium difficile, Staphylococcus Aureus, MRSA, and VRE. | | | | | | room occupant had one of these organisms, 1112 (3.2%) acquired the studied organism(s). The pooled acquisition odds ratio (OR) for all the organisms included in the six studies was 2.14 (95% CI: 1.65e2.77) |
| **Ulrich (2017)** | N/A | 1992-2014 | The Outbreak Database and PubMed | Hematology/ oncology department | VRE | To get a better insight into the characteristics of VRE outbreaks in hematology/oncology department | 35 | Case control, cohort and descriptive case series | N/A | N/A | The transmission mode was addressed in 12 articles, of which three articles named more than one transmission mode. Six articles report patient-to-patient transmission In 5 cases transmission through the hands of health care workers was reported and in another 4 cases transmission was due to a contaminated environment. |

C.diff : *Clostridioides difficile;*HAI: healthcare associated infection; ICU: intensive care unit; MRSA: methicillin resistant *Stahpylococcus aureus*; VRE: vancomycin resistant enterococcus spp.

## 3. Prevalence of colonisation in different patient populations and settings

**Systematic reviews**

We found six systematic reviews that reported on the prevalence of VRE-colonization in different populations and settings (11-16). No systematic reviews were found for LRE. The included systematic reviews included studies from all continents and studies were published between 2013 and 2019. Four of the included reviews reported on study design, all of which included observational studies. The reviews showed variation in included populations and settings.

Oncological patients

Aleviziakos et al found the pooled prevalence of VRE colonisation in patients with solid or hematologic malignancies to be 20% (11) based on studies on both inpatients and outpatients in USA, Canada, Europe, Asia and Oceania (11).

Paediatric population

Flokas et al found a stable 5% colonisation rate among the paediatric population screened. The rate was significantly higher among children hospitalised in haematology/oncology units (13).

Dialysis patients

Zacharioudakis et al found a pooled prevalence of VRE colonization was 6.2% (95% CI, 2.8%-10.8%) based on studies from 100 dialysis centres, with significant variability between centers (14).

ICU

Ziakas et al (2013) found that VRE colonization rates on admission varied widely from 0.1-42.6% (median 8.7%) (15). US prevalence estimates were higher compared to pooled estimates from European (2.7%, 95% CI 1.3-4.5), Asian (5.3%, 95% CI 2.0-10.2) and Australian (4.4%, 95% 1.5-8.8) studies.

Solid organ transplanted patients

Ziakas et al (2014) found that the range of reported prevalence for VRE colonization was 0–37.3% prior to transplantation and 0–31% after transplantation in patients from the USA and Brazil (16).

Healthcare workers

The systematic review by Peters et al investigated HCWs occupational risk of infection with MDROs in non-outbreak situations and found nine studies reporting on VRE (12). Their results showed colonization rates from 0 to 9.6%, although no VRE was found in most studies.

**Primary studies from the Nordic countries and the Netherlands**

Aro et al screened 447 asylum seekers and refugees on admission to a Helsinki University hospital in the period 2010 to 2017 (17). They found no VRE-positives. Koole et at found one VRE-positive patient after screening 51 Libyan war casualties on admission to a hospital in the Netherlands (18).

*Table 6 Overview of characteristics and findings of systematic reviews on prevalence of VRE in different populations and settings.*

| First author (Year) | Country | Search period | Databases | Setting/population | Pathogens | Study objective | No. studies incl. | Type of studies incl. | No. of patients | Quality assessment | Authors conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Alevizakos (2017)** | USA, Canada, Europe, Asia, Oseania | → 2016 | PubMed, Embase | Hospital; inpatients and outpatients. Adults and pediatric with solid or hematologic malignancy | VRE | Estimate VRE colonisation burden (prevalence and the risk of VRE BSI) in patients with malignancy | 34 | Prospective, retrospective studies | 8391 | Included studies did not contain adequate data to allow separate prevalence rates calculation across different time-points. Analysis on riskfactors were based on small number of studies. Not controlled for confounding. | Pooled prevalence of VRE colonisation was 20%. Patients with acute leukemia – RR 1,95 (1.17-3.26) for VRE colonisation. Vancomycin use or hospitalization within 3 months were associated with increased colonisation risk (RR 1,92; 1.06-3.45 og 4.68; 1.66-13.21) |
| **Flokas (2017)** | Asia, USA, Europe, South-America, Oceania, Africa | → 2016 | PubMed, Embase | Hospitalized children | VRE | To estimate the rate of VRE colonisation among hospitalised children, to identify pertinent risk factors and to evaluate the significance of colonisation on the development of subsequent VRE infections in the paediatric population. | 19 | Observational studies | 20234 | The Newcastle–Ottawa Scale (NOS). All studies – high quality. Most studies included were based on targeted screening, not al hospitalised children. Only 3 studies gave data on colonisation state at admission | The pooled rate of VRE gastrointestinal tract colonisation was 5% (95% CI 3–8%; τ2 = 0.03) without a small study effect (ET = 0.62, PET = 0.162). Two studies were performed in Europe (one in Germany [33] and one in the UK [34]) with a pooled rate of 7% (95% CI 5–9%). The rate was significantly higher among children hospitalised in haematology/oncology units, and colonisation was associated with previous exposure to vancomycin and ceftazidime.<br><br>In other unites 23% (18-29% CI). Previous vancomycin (RR 4.34 or ceftazidime (RR 4.15 was riskfactors. |
| **Peters C (2019)** | Europe, North America, South America, Asia, Africa | 2000-2019 | PubMed, MEDLINE/Ovid, Web of Science, and CINAHL | Hospital or geriatric care | MDROs | The occupational risk of infection with multidrug-resistant organisms in non-outbreak situations for employees in the health service | 22 | Cross-sectional | N/A | The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews. Checklist for Prevalence Studies.<br>The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies | Only very few, high-quality studies are available worldwide on MDROs in health personnel.<br><br>Overall, there were only very few studies that defined the presence and prevalence of MDROs in employees as their study objectives. Patients or residents were often the main target group, and employees were only included incidentally in the investigations. |

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| | | | | | | | | | | | VRE-testing in nine studies showed colonization rates from 0 to 9.6%, although no VRE was found in most studies. |
| **Zacharioudakis (2015)** | North America, Europe, Asia, Oceania, South America | 1976-2014 | PubMed and EMBASE | Dialysis centres | VRE | (1) prevalence of VRE colonization and (2) impact of risk factors on VRE colonization (3) Long-term risk om VRE infection among colonized | 23 | Cross-sectional | 4842 | Most studies had screened a low percentage of the unit`s patients. All relatives effect are unadjusted for potential confounders and therefore provide only a crude measure of association | The pooled prevalence of VRE colonization was 6.2% (95% CI, 2.8%-10.8%), with significant variability between centers. Previous antibiotic use, in particular vancomycin, and recent hospitalization are important predicting factors of colonization, whereas the risk of VRE infection is significantly higher for colonized patients. Other risk factors that are related to the physical status of residents include the presence of decubitus ulcers, the presence of wounds, urinary incontinence, the presence of comorbidities, and fecal incontinence. In addition, several articles report prior hospitalization as a risk factor |
| **Ziakas (2013)** | US, Asia, Europe, Oceania, and S. America | → 2013 | Pubmed and EMBASE | ICU | VRE | (a). The prevalence of VRE colonization upon admission. | 37 | N/A | N/A | No standard checklist. Studies were given quality points based on items regarding optimal research design and quality of reporting as previously described for schizophrenia | VRE colonization rates on admission varied widely from 0.1-42.6% (median 8.7%). US prevalence estimates were higher compared to pooled estimates from European (2.7%, 95% CI 1.3-4.5), Asian (5.3%, 95% CI 2.0-10.2) and Australian (4.4%, 95% 1.5-8.8) studies. |
| **Ziakas (2014)** | USA and Brazil | → 2013 | MEDLINE and EMBASE | Solid organ transplantation | MRSA and VRE | 1) Prevalence of MRSA and VRE colonization 2) the risk of MRSA and VRE infection relative to colonization status | 25 (11 VRE) | N/A | N/A | Newcastle-Ottawa Quality Assessment Scale | The range of reported prevalence for VRE colonization was 0–37.3% prior to transplantation and 0–31% after transplantation. Pooled effects VRE colonization was 11.9% (95% CI 6.8–18.2; effect derived from eight studies that included 1381 patients (t2¼ 0.060). In the postoperative screening, across eight VRE studies (14,16–18,20,27,30,36) with 1369 patients (six on liver transplant recipients, one on kidney and one on kidney and/or pancreas), colonization was 16.2% (95% CI 10.7–22.6); t2 ¼ 0.051. VRE rectal carriage, both prior and after transplantation, significantly increases the risk of VRE infection. |

BSI: bloodstream infection; C.diff; **ICU: intensive care unit;** MDROs: multidrug resistant organism; **MRSA: methicillin resistant *Stahpylococcus aureus*; VRE: vancomycin resistant enterococcus spp.**

*Table 7. Overview of characteristics and findings of studies from the Nordic countries and the Netherlands on prevalence of VRE in different populations and settings.*

| First author (Year) | Country | Study design | Study period | Setting/ population | Pathogens | Study objective | Screening type | Screening site | No. of screened patients | No. of positive patients | Prevalence | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Aro (2018)** | Finland | Retrospective cohort | 2010-2017 | Hospital/ asylum seekers and refugees | MRSA, VRE, ESBL-PE, CPE, MRAB, MRPA | Invesigate the prevalence of various MDR bacteria among asylum seekers and refugees hospitalised in Finland, and seeks risk factors that can be used to identify those at highest risk of colonisation. | Admission screening | | 447 | 0 | | No VRE-positive patients |
| **Koole (2013)** | Netherlands | Prospective cohort | | War casualties – male, median age 30 | MRSA, VRE, ESBL | Establish the prevalence of multidrug-resistant (MDR) bacteria in Libian war casualties and to identify the associated risk factors. | Admission screening | Perineum | 51 | 1 | 2% | One VRE-positive patient. In total 30 patients were colonized with MDR, ESBL producing bacteria the most common |

MRSA: meticillin-resistant *Staphylococcus aureus*; VRE: vancomycin-resistant *Enterococcus*; ESBL-PE: extended-spectrum beta-lactamase-producing *Enterobacteriaceae*; CPE: carbapenemase-producing *Enterobacteriaceae*; MRAB: multiresistant *Acinetobacter baumannii*; MRPA: multiresistant *Pseudomonas aeruginosa*

## 4. Associated factors

We included seven systematic reviews that reported on the individual factors associated with VRE infection/colonisation (Table 7) (7, 11, 13, 14, 19-21). No systematic reviews were found for LRE. The included systematic reviews included studies from all continents and studies were published between 2011 and 2023. Studies of different designs were included in the systematic reviews. The study settings were mainly hospitals, except from van Buul et al. who reported on LTCFs.

All of the systematic reviews found previous antibiotic use as the most important reported associated factor for VRE colonization or infection, and three reviews reported prior vancomycin treatment as a distinct factor, which indicates a robust relationship across different settings and study designs (11, 13, 14). Other associated factors were recent hospitalisation (11, 14), ICU-stay (7), invasive devices (7, 21), presence of wounds (14) and incontinence (14). Van Buul et al. also reported lower functional status as an associated factor among LTCF residents (21).

*Tabel 8. Overview and findings of systematic reviews on associated factors of VRE colonisation/infection.*

| Author (Year) | Country | Search period | Databases | Setting/ population | Pathogens | Study objective | No. studies incl. | Type of studies incl. | No. of patients | Quality assesment | Authors conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ajao AO (2011)** | USA, Europe, Canada, Hong Kong | → 2009 | MEDLINE | Hospital; ICU, medical ward | MRSA, VRE, C.diff | Measure and define colonization pressure and risk factors associated with MDRO | 18 (8 on VRE) | Prospective/retrospective cohort, case-control | - | Definition of colonisation pressure varied between studies. Only 6 studies included colonization pressure in multivariable analysis | Risk factors: environmental contamination, enteral feeding, leukemia, end-stage renal disease, pre-ICU and ICU length of stay, ICU antibiotic use |
| **Alevizakos M (2017)** | USA, Canada, Europe, Asia, Oseania | → 2016 | PubMed, Embase | Hospital; inpatients and outpatients. Adults and pediatric with solid or hematologic malignancy | VRE | Estimate VRE colonisation burden (prevalence and the risk of VRE BSI) in patients with malignancy | 34 | Prospective, retrospective studies | 8391 | Included studies did not contain adequate data to allow separate prevalence rates calculation across different time-points. Analysis on riskfactors were based on small number of studies. Not controlled for confounding. | Pooled prevalence of VRE colonisation was 20%. Patients with acute leukemia – RR 1,95 (1.17-3.26) for VRE colonisation. Vancomycin use or hospitalization within 3 months were associated with increased colonisation risk (RR 1,92; 1.06-3.45 og 4.68; 1.66-13.21) |
| **Danielsen A S (2023)** | USA, Asia, Europe | 2015 - 2021 | MEDLINE, Embase, Cinahl, Web of Science | Hospital; mainly heamtological cancer patients | Gramnegatives, C.diff, Enterococcus, fungi, | Review multivariable models of resistant infections/colonisations and corresponding mortality,what risk factors have been investigated and methological approaches | 144 (11 on VRE) | - | 72-342 in 8 studies modelling the risk of being colonized/infected with VRE | - | Antibiotic exposure (different AB), neutropenia associated with VRE infection. Due to differences in patient populations selected in studies and the different way of grouping microbes it is difficult to infer which risk factors are of importance. Difficult to do meta-analysis or pooled analysis. |
| **Flokas M E (2017)** | Asia, USA, Europe, South-America, Oceania, Africa | → 2016 | PubMed, Embase | Hospitalized children | VRE | To estimate the rate of VRE colonisation among hospitalised children, to identify pertinent risk factors and to evaluate the significance of colonisation on the development of subsequent VRE infections in the paediatric population | 19 | Observational studies | 20234 | All studies – high quality. Most studies included were based on targeted screening, not al hospitalised children. Only 3 studies gave data on colonisation state at admission | The pooled rate of VRE gastrointestinal tract colonisation was 5% (95% CI 3–8%; $\tau 2 = 0.03$) without a small study effect (ET = 0.62, PET = 0.162). Two studies were performed in Europe (one in Germany [33] and one in the UK [34]) with a pooled rate of 7% (95% CI 5–9%). The rate was significantly higher among children hospitalised in haematology/oncology units, and colonisation was associated with previous exposure to vancomycin (RR 4.34) and ceftazidime (RR 4.15). |
| **Sulis G (2022)** | High-income-, uppermiddle-income | From inception to 2020 | Embase, Ovid Medline, Scopus, The Cochrane Database of Systematic | Inpatient care settings (307, 86.0%, of which 65 in ICU only) | CRAB, CRE, CRPA, ESBL-EB, MRSA and VRE | We collated the evidence on the association between prior exposure to antibiotics belonging to each AWaRe category and documented subsequent detection of colonization/ infection with antibiotic-resistant bacteria. We | 349 ((59 in VRE) | Case-control studies (231, 64.7%) | N/A | Tailored checklists based on The Cochrane's Risk Of Bias In Non-randomized Studies of Interventions tool and the Scottish Intercollegiate Guideline Network checklist. | Pooled estimates suggest that almost all antibiotics/classes belonging to each AWaRe category were significantly associated with an increased risk of colonization/infection with any |

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| | countries | | Reviews, Cochrane Central Register of Controlled Trials, and ClinicalTrials.gov | | | hypothesized that the use of Access-group antibiotics is less likely to be associated with subsequent patient MDRO colonization/infection than the use of Watch- or Reserve-group antibiotics | | | | | MDRO. However, ORs were more frequently higher for Watch and Reserve antibiotics |
| **van Buul L W (2012)** | N/A | N/A | MEDLINE and Embase | LTCF (nursing homes and residental care) | Antibiotic-resistant pathogens | Providing a comprehensive overview of the literature on antibiotic use, antibiotic resistance, and strategies to reduce antibiotic resistance, thereby focusing on long term care facilities | 159 | Original articles, reviews, letters, reports, editorials and guidelines | N/A | N/A | At the resident level, prior antibiotic treatment was most frequently reported as a risk factor for colonization or infection with antibiotic-resistant organisms, followed by the presence of invasive devices, such as urinary catheters or feeding tubes. Another frequently reported risk factor is lower functional status |
| **Zacharioudakis (2015)** | North America, Europe, Asia, Oceania, South America | 1976-2014 | Pubmed and Embase | Dialysis centres | VRE | (1) VRE colonization and (2) rate of VRE infection among colonized and noncolonized individuals | 23 | Type of studies incl. | 4842 | Risk of bias | VRE colonization is prevalent in dialysis centers. Previous antibiotic use, in particular vancomycin, and recent hospitalization are important predicting factors of colonization, whereas the risk of VRE infection is significantly higher for colonized patients. Other risk factors that are related to the physical status of residents include the presence of decubitus ulcers, the presence of wounds, urinary incontinence, the presence of comorbidities, and fecal incontinence. In addition, several articles report prior hospitalization as a risk factor |

*CRAB: carbapenem-resistant Acinetobacter baumannii; CRE: carbapenem-resistant Enterobacterales; CRP: carbapenem-resistant Pseudomonas aeruginosa; ESBL-EB: extended-spectrum beta-lactamase producing Enterobacterales; MRSA: methicillin-resistant Staphylococcus aureus; VRE: vancomycin-resistant Enterococcus spp

# Conclusion

**Duration of colonisation**

Assessments of duration of colonisation and long-time carriage remain challenging based on identified studies due to a lack of standardised testing protocols and definitions. However, there might be a trend of decolonisation over time. A small Danish study suggests that patients may be recolonised with new clones, rather than remain persistently colonised with the same clone.

**Risk of transmission**

Studies on risk of infection/colonisation with VRE after exposure to an infected/colonised roommate or rooms previously occupied by infected/colonised patients are inconclusive, and few studies investigated VRE specifically. The exposure may increase the risk of transmission, but the evidence is scarce. The role of environmental transmission for VRE should be further investigated.

**Prevalence of colonisation in different patient populations and settings**

The included studies demonstrate the prevalence of VRE in different patient populations, and we observe that all the studies initially investigate particularly sick or vulnerable patient groups. Further interpretation of the results should be done with caution, as the studies, which mainly focuses on pooled prevalences in patients from different world regions, may not be applicable to a Norwegian/Nordic setting with low prevalences. Results on HCW are highly variable from study to study.

**Associated factors**

The included reviews provide clear evidence that previous antibiotic use, especially vancomycin, is a risk factor for VRE colonisation or infection. Other factors associated with colonisation, such as recent hospitalisation, ICU stay, invasive devices, wounds and incontinence, were also reported. It is important to note that most of the studies are based on hospitalised patients and their findings may not apply to a targeted screening programme.

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# Appendix: search strategies

**VRE/LRE**

| | |
|---|---|
| **Contact person:** | Mari Molvik |
| **Search:** | Ragnhild Agathe Tornes |
| **Peer review:** | Astrid Merete Nøstberg |
| **Duplicate control in EndNote:** | Before duplicate control: 1610 (492 systematic reviews, 1118 primary studies)<br>After duplicate control: 1009 (278 systematic reviews, 731 primary studies) |

| | |
|---|---|
| **Database:** | **Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions <1946 to November 30, 2023>** |
| **Date:** | December 1, 2023 |
| **Number of hits:** | 133 systematic reviews, 505 primary studies |

| | | |
|---|---|---|
| 1 | Vancomycin-Resistant Enterococci/ | 1045 |
| 2 | (((vancomycin or VAN or linezolid) adj resistant enterococc*) or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) adj2 enterococc*)).tw,kf. | 6084 |
| 3 | 1 or 2 | 6212 |
| 4 | limit 3 to "reviews (maximizes specificity)" | 131 |
| 5 | Meta-Analysis/ or Network Meta-Analysis/ or ((systematic* adj2 review*) or metaanal* or "meta anal*" or (review and ((structured or database* or systematic*) adj2 search*)) or "integrative review*" or (evidence adj2 review*)).tw,kf,bt. | 537114 |
| 6 | 4 or (3 and 5) | 153 |
| 7 | exp "Scandinavian and Nordic Countries"/ or "Scandinavians and Nordic People"/ or Netherlands/ | 294866 |
| 8 | (Scandinavi* or nordic or Norway or norwegian? or Norge or Svalbard or Spitsbergen or Jan Mayen or Sweden or swedish or swede? or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* or "Fa?roe Islands" or fa?roes* or Greenland or Kalaallit Nunaat or Netherland* or Holland or Dutch).tw,cp,in,lg,kf,pl. | 3972944 |
| 9 | (sykehus* or sjukehus* or ((universitet* or University or univ) adj3 (haukeland or nordnorge or norge* or bergen or stavanger or tromso or tromsoe or trondheim or levanger or gjovik or gjoevik or harstad or | 60392 |

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| | lillehammer or narvik or nesna or stord or haugesund or volda or aalesund or alesund)) or ((universitet* or University or univ) adj1 nord) or sentralsjukehus* or sentralsykehus* or Finnmarkssykehuset or Helgelandssykehuset or Nordlandssykehuset or innlandet or "Olav? Hospital?" or revmatismesykehus or lungesykehus or "Hospitalet Betanien" or Kysthospitalet or Aleris or Feiringklinikken or Glittreklinikken or "Hjertesenteret i Oslo" or "Medi 3" or "Volvat Medisinske Senter" or "Helse Vest" or "Helse Stavanger" or "Helse fonna" or "helse bergen" or "helse forde" or "helse foerde" or sjukehusapotek* or sykehusapotek* or "helse midt norge" or "helse midtnorge" or "Ambulanse Midtnorge" or "Ambulanse Midt norge" or "helse nord" or "Helse Sorost" or "Helse Sor ost" or "Helse Soeroest" or "Helse Soer oest" or sunnaas or sunnas or sorlandet or soerlandet).cp,in,tw,kf,pl. | |
| 10 | (Akershus or Viken or Austagder or Agder or Buskerud or Finnmark or Hedmark or Hordaland or Romsdal or Nordland or Nordtrondelag or Trondelag or Nordtroendelag or Troendelag or Oppland or Oslo or Rogaland or Fjordane or Sortrondelag or Soertroendelag or Telemark or Troms or Vestagder or Vestfold or Ostfold or Oestfold or Longyearbyen or innlandet or vestland).cp,in,tw,kf,pl. | 101568 |
| 11 | (sjukhus* or centralsjukhus* or laenssjukhus* or lanssjukhus* or lansdelssjukhus* or laensdelssjukhus* or barnsjukhus* or ungdomssjukhus* or lasarett* or Regionsjukhus* or Narsjukhus* or Naersjukhus* or Specialistsjukhus* or Beckombergasykehuset or "Danvikens hospital" or Konradsberg or "karolinska institute?" or (karolinska adj2 hosp*) or ("astrid lindgren" adj2 hosp*) or sahlgrenska or Radiumhemmet or Sophiahemmet or Sodersjukhuset or Soedersjukhuset or Blekingesjukhuset or Anestesiklinik* or Linneuniversitetet or Mittuniversitetet or "Royal Institute of Technology" or ((Universitet* or universit* or univ) adj2 (norrland* or skaane? or skane? or lindkoping or orebro or lindkoeping or oerebro or lund or lunds or uppsala or gothenborg? or gothenburg? or goteborg? or goteburg? or goethenborg? or goethenburg? or goeteborg? or goeteburg? or umeaa? or umea? or luleaa or lulea or karlstad? or vaxjo or vaexjo or vaxjoe or vaexjoe or kalmar or tekniska or Linnaeus or Chalmers or malmo or malmoe or Malardalen? or Maelardalen? or karolinska))).cp,in,tw,kf,pl. | 326911 |
| 12 | (Blekinge or dalarna? or gotland or gavleborg? or gaevleborg? or halland or jamtland* or jaemtland* or jonkoping? or joenkoping? or kalmar? or kronoberg? or norbotten or skaane or skane or stockholm? or sodermanland? or soedermanland? or uppsala? or varmland? or vaermland? or vasterbotten? or vaesterbotten? or vasternorrland? or vaesternorrland? or vastmanland? or vaestmanland? or gotaland? or orebro? or "oster gotland?" or goetaland? or oerebro? or "oester gotland?").cp,in,tw,kf,pl. | 240300 |
| 13 | (sygehus* or ((Universitet* or universit* or hospital* or hosp) adj3 (amager* or Augustenborg* or Bornholm* or farso* or give or herning* or hobro* or koge or koege or oringe* or randers or ringsted* or skagen* or | 258245 |

| | | |
|---|---|---|
| | "sct. hans*" or tarm or tonder* or toender* or thisted* or vejle* or viborg* or Aalborg* or aarhus* or Alborg* or arhus*)) or Specialhospital* or Universitetshospital* or Regionshospital* or "Psykiatrisk Cent*" or "Psykoterapeutisk Cent*" or Psykiatricenter* or Kommunehospital* or Centralsygeh* or "Hammel Neurocenter*" or "Vest Ribe*" or Aabenraa* or Abenra* or Aeroskobing* or Aroskobing* or Aeroeskobing* or Aroeskobing* or allerup* or Bispebjerg* or Bronderslev* or Broenderslev* or copenhagen* or Esbjerg* or Fakse or Fredericia* or Frederiksberg* or frederikshavn* or Gentofte* or Glostrup* or Grenaa* or Grena* or Grindsted* or Haderslev* or Herlev* or Hjorring* or Hjoerring* or holbaek* or Holbak* or Holstebro* or Horsens* or hovedstaden* or Hvidovre* or Kalundborg* or kobenhavn* or koebenhavn* or Kolding* or Korsor* or Korsoer* or Lemvig* or Middelfart* or Midtjylland* or Naestved* or Nakskov* or Nastved* or Nordjylland* or Nordsjaelland* or Nordsjalland* or Nykobing* or Nykoebing* or Odense* or Poppelhus* or Rigshospitalet* or Ringkobing* or Ringkoebing* or Risskov* or Roskilde* or Silkeborg* or Sjaelland* or Sjalland* or Skanderborg* or Skejby* or Slagelse* or Sonderborg* or Soenderborg* or Stolpegaard* or Svendborg* or Syddanmark* or sydvestjysk* or Syddansk* or "Tekniske Universitet*" or "IT Universitetet*" or ITUniversitetet* or "aarhus univ*" or "aalborg univ*" or "U of Aarhus*" or "U of aalborg*" or "Univ of Aarhus*" or "Univ of aalborg*" or "arhus univ*" or "alborg univ*" or "U of Arhus*" or "U of alborg*" or "Univ of Arhus*" or "Univ of alborg*").tw,cp,in,kf,pl. | |
| 14 | (tidsskrift for den norske laegeforening or lakartidningen or ugeskrift for laeger).jn. | 110377 |
| 15 | or/7-14 | 4007989 |
| 16 | 3 and 15 | 770 |
| 17 | 16 not 6 | 748 |
| 18 | limit 6 to yr="2009 -Current" | 133 |
| 19 | limit 17 to yr="2009 -Current" | 505 |

**Database:** Embase <1974 to 2023 November 30> via Ovid

**Date:** December 1, 2023

**Number of hits:** 228 systematic reviews, 355 primary studies

| | | |
|---|---|---|
| 1 | vancomycin resistant Enterococcus/ | 7399 |

| | | |
|---|---|---|
| 2 | (((vancomycin or VAN or linezolid) adj resistant enterococc*) or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) adj2 enterococc*)).tw,kf. | 7928 |
| 3 | 1 or 2 | 10686 |
| 4 | limit 3 to (conference abstracts or embase or "preprints (unpublished, non-peer reviewed)") | 9890 |
| 5 | limit 4 to "reviews (maximizes specificity)" | 152 |
| 6 | exp Meta-Analysis/ or "systematic review"/ or ((systematic* adj2 review*) or metaanal* or "meta anal*" or (review and ((structured or database* or systematic*) adj2 search*)) or "integrative review*" or (evidence adj2 review*)).tw,kf,bt. | 773167 |
| 7 | 5 or (4 and 6) | 276 |
| 8 | exp scandinavia/ or exp north germanic people/ or Netherlands/ | 322168 |
| 9 | (Scandinavi* or nordic or Norway or norwegian? or Norge or Svalbard or Spitsbergen or Jan Mayen or Sweden or swedish or swede? or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* or "Fa?roe Islands" or fa?roes* or Greenland or Kalaallit Nunaat or Netherland* or Holland or Dutch).in,ad,tw,lg,kf. | 2531847 |
| 10 | (sykehus* or sjukehus* or ((universitet* or University or univ) adj3 (haukeland or nordnorge or norge* or bergen or stavanger or tromso or tromsoe or trondheim or levanger or gjovik or gjoevik or harstad or lillehammer or narvik or nesna or stord or haugesund or volda or aalesund or alesund)) or ((universitet* or University or univ) adj1 nord) or sentralsjukehus* or sentralsykehus* or Finnmarkssykehuset or Helgelandssykehuset or Nordlandssykehuset or innlandet or "Olav? Hospital?" or revmatismesykehus or lungesykehus or "Hospitalet Betanien" or Kysthospitalet or Aleris or Feiringklinikken or Glittreklinikken or "Hjertesenteret i Oslo" or "Medi 3" or "Volvat Medisinske Senter" or "Helse Vest" or "Helse Stavanger" or "Helse fonna" or "helse bergen" or "helse forde" or "helse foerde" or sjukehusapotek* or sykehusapotek* or "helse midt norge" or "helse midtnorge" or "Ambulanse Midtnorge" or "Ambulanse Midt norge" or "helse nord" or "Helse Sorost" or "Helse Sor ost" or "Helse Soeroest" or "Helse Soer oest" or sunnaas or sunnas or sorlandet or soerlandet).in,ad,ti,ab,kf. | 90073 |
| 11 | (Akershus or Viken or Austagder or Agder or Buskerud or Finnmark or Hedmark or Hordaland or Romsdal or Nordland or Nordtrondelag or | 152889 |

| | | |
|---|---|---|
| | Trondelag or Nordtroendelag or Troendelag or Oppland or Oslo or Rogaland or Fjordane or Sortrondelag or Soertroendelag or Telemark or Troms or Vestagder or Vestfold or Ostfold or Oestfold or Longyearbyen or innlandet or vestland).in,ad,ti,ab,kf. | |
| 12 | (oslonorway or bergennorway or sandnesnorway or stavangernorway or trondheimnorway or tromsonorway or tromsoenorway or Akershusnorway or Vikennorway or Austagdernorway or Agdernorway or Buskerudnorway or Finnmarknorway or Hedmarknorway or Hordalandnorway or Romsdalnorway or Nordlandnorway or Nordtrondelagnorway or Nordtroendelagnorway or Trondelagnorway or Troendelagnorway or Opplandnorway or Rogalandnorway or Fjordanenorway or Sortrondelagnorway or Sortroendelagnorway or Telemarknorway or Tromsnorway or Vestagdernorway or Vestfoldnorway or Ostfoldnorway or Oestfoldnorway or innlandetnorway or vestlandnorway).in,ad,ti,ab,kf. | 703 |
| 13 | (sjukhus* or centralsjukhus* or laenssjukhus* or lanssjukhus* or lansdelssjukhus* or laensdelssjukhus* or barnsjukhus* or ungdomssjukhus* or lasarett* or Regionsjukhus* or Narsjukhus* or Naersjukhus* or Specialistsjukhus* or Beckombergasykehuset or "Danvikens hospital" or Konradsberg or "karolinska institute?" or (karolinska adj2 hosp*) or ("astrid lindgren" adj2 hosp*) or sahlgrenska or Radiumhemmet or Sophiahemmet or Sodersjukhuset or Soedersjukhuset or Blekingesjukhuset or Anestesiklinik* or Linneuniversitetet or Mittuniversitetet or "Royal Institute of Technology" or ((Universitet* or universit* or univ) adj2 (norrland* or skaane? or skane? or lindkoping or orebro or lindkoeping or oerebro or lund or lunds or uppsala or gothenborg? or gothenburg? or goteborg? or goteburg? or goethenborg? or goethenburg? or goeteborg? or goeteburg? or umeaa? or umea? or luleaa or lulea or karlstad? or vaxjo or vaexjo or vaxjoe or vaexjoe or kalmar or tekniska or Linnaeus or Chalmers or malmo or malmoe or Malardalen? or Maelardalen? or karolinska))).in,ad,ti,ab,kf. | 472874 |
| 14 | (Blekinge or dalarna? or gotland or gavleborg? or gaevleborg? or halland or jamtland* or jaemtland* or jonkoping? or joenkoping? or kalmar? or kronoberg? or norbotten or skaane or skane or stockholm? or sodermanland? or soedermanland? or uppsala? or varmland? or vaermland? or vasterbotten? or vaesterbotten? or vasternorrland? or vaesternorrland? or vastmanland? or vaestmanland? or gotaland? or | 359932 |

| | | |
|---|---|---|
| | orebro? or "oster gotland?" or goetaland? or oerebro? or "oester gotland?").in,ad,ti,ab,kf. | |
| 15 | (norrlandsweden or skaanesweden or skanesweden or lindkopingsweden or lindkoepingsweden or orebrosweden or oerebrosweden or lundsweden or uppsalasweden or gothenborgsweden or gothenburgsweden or goteborgsweden or goteburgsweden or goethenborgsweden or goethenburgsweden or goeteborgsweden or goeteburgsweden or umeaasweden or umeasweden or luleaasweden or luleasweden or karlstadsweden or vaxjosweden or vaexjosweden or vaxjoesweden or vaexjoesweden or kalmarsweden or malmosweden or malmoesweden or Malardalensweden or Maelardalensweden or Blekingesweden or dalarnasweden or gotlandsweden or gavleborgsweden or gaevleborgsweden or hallandsweden or jamtlandsweden or jaemtlandsweden or jonkopingsweden or joenkopingsweden or kalmarsweden or kronobergsweden or norbottensweden or stockholmsweden or sodermanlandsweden or soedermanlandsweden or uppsalasweden or varmlandsweden or vaermlandsweden or vasterbottensweden or vaesterbottensweden or vasternorrlandsweden or vaesternorrlandsweden or vastmanlandsweden or vaestmanlandsweden or gotalandsweden or goetalandsweden or orebrosweden or oerebrosweden or gotlandsweden or Vasteraassweden or Vaesterassweden or helsingborgsweden or norrkopingsweden or norrkoepingsweden).in,ad,ti,ab,kf. | 2034 |
| 16 | (sygehus* or ((Universitet* or universit* or hospital* or hosp) adj3 (amager* or Augustenborg* or Bornholm* or farso* or give or herning* or hobro* or koge or koege or oringe* or randers or ringsted* or skagen* or "sct. hans*" or tarm or tonder* or toender* or thisted* or vejle* or viborg* or Aalborg* or aarhus* or Alborg* or arhus*)) or Specialhospital* or Universitetshospital* or Regionshospital* or "Psykiatrisk Cent*" or "Psykoterapeutisk Cent*" or Psykiatricenter* or Kommunehospital* or Centralsygeh* or "Hammel Neurocenter*" or "Vest Ribe*" or Aabenraa* or Abenra* or Aeroskobing* or Aroskobing* or Aeroeskobing* or Aroeskobing* or allerup* or Bispebjerg* or Bronderslev* or Broenderslev* or copenhagen* or Esbjerg* or Fakse or Fredericia* or Frederiksberg* or frederikshavn* or Gentofte* or Glostrup* or Grenaa* or Grena* or Grindsted* or Haderslev* or Herlev* or Hjorring* or Hjoerring* or holbaek* or Holbak* or Holstebro* or Horsens* or hovedstaden* or | 387482 |

| | | |
|---|---|---|
| | Hvidovre* or Kalundborg* or kobenhavn* or koebenhavn* or Kolding* or Korsor* or Korsoer* or Lemvig* or Middelfart* or Midtjylland* or Naestved* or Nakskov* or Nastved* or Nordjylland* or Nordsjaelland* or Nordsjalland* or Nykobing* or Nykoebing* or Odense* or Poppelhus* or Rigshospitalet* or Ringkobing* or Ringkoebing* or Risskov* or Roskilde* or Silkeborg* or Sjaelland* or Sjalland* or Skanderborg* or Skejby* or Slagelse* or Sonderborg* or Soenderborg* or Stolpegaard* or Svendborg* or Syddanmark* or sydvestjysk* or Syddansk* or "Tekniske Universitet*" or "IT Universitetet*" or ITUniversitetet* or "aarhus univ*" or "aalborg univ*" or "U of Aarhus*" or "U of aalborg*" or "Univ of Aarhus*" or "Univ of aalborg*" or "arhus univ*" or "alborg univ*" or "U of Arhus*" or "U of alborg*" or "Univ of Arhus*" or "Univ of alborg*").in,ad,ti,ab,kf. | |
| 17 | (amagerdenmark or Augustenborgdenmark or Bornholmdenmark or farsodenmark or farsoedenmark or givedenmark or herningdenmark or hobrodenmark or kogedenmark or koegedenmark or oringedenmark or randersdanmark or ringsteddenmark or tarmdenmark or thisteddenmark or tonderdenmark or toenderdenmark or Vejledanmark or viborgdenmark or Aalborgdenmark or aarhusdenmark or Alborgdenmark or arhusdenmark).in,ad,ti,ab,kf. | 323 |
| 18 | (tidsskrift for den norske laegeforening or tidsskrift for den norske laegeforening tidsskrift for praktisk or tidsskrift for den norske laegeforening tidsskrift for praktisk medicin ny raekke or Norsk Epidemiologi or lakartidningen or ugeskrift for laeger).jn. | 94340 |
| 19 | or/8-18 | 2588836 |
| 20 | 4 and 19 | 560 |
| 21 | 20 not 7 | 541 |
| 22 | limit 7 to yr="2009 -Current" | 228 |
| 23 | limit 21 to yr="2009 -Current" | 355 |

**Database:** **Cochrane Database of Systematic Reviews**

**Issue 11 of 12, November 2023**

**Cochrane Central Register of Controlled Trials**

**Issue 11 of 12, November 2023**

**Date:** December 4, 2023

**Number of hits:** 0 systematic reviews, 4 primary studies

| | | |
|---|---|---|
| #1 | [mh ^"Vancomycin-Resistant Enterococci"] | 18 |
| #2 | (((vancomycin or VAN or linezolid) NEXT ("resistant enterococci" or "resistant enterococcus")) or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) NEAR/2 enterococc*)):ti,ab | 191 |
| #3 | #1 or #2 | 193 |
| #4 | [mh "Scandinavian and Nordic Countries"] or [mh ^"Scandinavians and Nordic People"] or [mh Netherlands] | 12717 |
| #5 | (Scandinavi* or nordic or Norway or norwegian? or Norge or Svalbard or Spitsbergen or "Jan Mayen" or Sweden or swedish or swede? or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* or "Faroe Islands" or "Faeroe Islands" or fa?roes* or Greenland or "Kalaallit Nunaat" or Netherland* or Holland or Dutch):ti,ab | 37428 |
| #6 | #4 or #5 | 42259 |
| #7 | #3 and #6 | 6 |
| #8 | #3 with Cochrane Library publication date Between Jan 2009 and Dec 2023, in Cochrane Reviews | 0 |
| #9 | #3 and #6 with Publication Year from 2009 to 2023, in Trials | 4 |

**Database:** **Web of Science Core Collection**

**- WOS.SCI: 1987 to 2023**

**- WOS.AHCI: 1987 to 2023**

**- WOS.ESCI: 2018 to 2023**

**- WOS.SSCI: 1987 to 2023**

**Date:** December 5, 2023

**Number of hits:** 127 systematic reviews, 244 primary studies

| | | | |
|---|---|---|---|
| 1 | TS=(((vancomycin or VAN or linezolid) NEAR/0 "resistant enterococc*") or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) NEAR/1 enterococc*)) | Exact search | 7026 |
| 2 | TS=(("systematic*" NEAR/1 "review*") or ("review" and (("structured" or "database*" or "systematic*") NEAR/1 "search*")) or "integrative review*" or ("evidence" NEAR/1 "review*")) OR TI=("metaanal*" or "meta anal*") OR AB=("metaanal*" or "meta anal*") | Exact search | 598031 |
| 3 | #1 AND #2 | Exact search | 141 |
| 4 | #1 AND (CU==("NORWAY" OR "SWEDEN" OR "DENMARK" OR "FINLAND" OR "ICELAND" OR "NETHERLANDS")) | Exact search | 437 |
| 5 | #4 not #3 | Exact search | 429 |
| 6 | #3<br>Timespan: 2009-01-01 to 2023-12-31 | Exact search | 127 |
| 7 | #5<br>Timespan: 2009-01-01 to 2023-12-31 | Exact search | 244 |

**Database:** **Epistemonikos**

**Date:** December 4, 2023

**Number of hits:** 4 systematic reviews, 10 primary studies

Title/abstract: ("vancomycin resistant enterococci" or "linezolid resistant enterococci" or "VAN resistant enterococci" or "VAN resistant Enterococcus" or "VAN−R enterococci" or "VAN−R Enterococcus" or "VRE (enterococcus)" or "LRE (enterococcus)")

Publication type: Systematic Review

Publication year: Custom year range From: 2009 To: 2023

4 hits

Title/abstract: (("vancomycin resistant enterococci" or "linezolid resistant enterococci" or "VAN resistant enterococci" or "VAN resistant Enterococcus" or "VAN−R enterococci" or "VAN−R Enterococcus" or "VRE (enterococcus)" or "LRE (enterococcus)") and (Scandinavi* or nordic or Norway or Norwegian* or Norge or Svalbard or Spitsbergen or "Jan Mayen" or Sweden or swedish or swede* or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* or "Faroe Islands" or "Faeroe Islands" or faroes* or faeroes* or Greenland or "Kalaallit Nunaat" or Netherland* or Holland or Dutch))

Publication type: Primary Study

Publication year: Custom year range From: 2009 To: 2023

10 hits

**VRE/LRE and colonization**

| | |
|---|---|
| **Contact person:** | Mari Molvik |
| **Search:** | Ragnhild Agathe Tornes |
| **Duplicate control in EndNote:** | Before duplicate control: 335 |

After duplicate control: 198

**Database:** Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions <1946 to August 29, 2024>

**Date:** September 2 2024

**Number of hits:** 147

| | | |
|---|---|---|
| 1 | Vancomycin-Resistant Enterococci/ | 1128 |
| 2 | (((vancomycin or VAN or linezolid) adj resistant enterococc*) or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) adj2 enterococc*)).tw,kf. | 6350 |
| 3 | 1 or 2 | 6481 |
| 4 | (colonis* or coloniz* or carrier? or screening?).tw,kf. | 1114026 |
| 5 | 3 and 4 | 1766 |
| 6 | exp "Scandinavian and Nordic Countries"/ or "Scandinavians and Nordic People"/ or Netherlands/ | 300391 |
| 7 | (Scandinavi* or nordic or Norway or norwegian? or Norge or Svalbard or Spitsbergen or Jan Mayen or Sweden or swedish or swede? or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* or "Fa?roe Islands" or fa?roes* or Greenland or Kalaallit Nunaat or Netherland* or Holland).tw,cp,in,lg,kf,pl. | 4142235 |
| 8 | (sykehus* or sjukehus* or ((universitet* or University or univ) adj3 (haukeland or nordnorge or norge* or bergen or stavanger or tromso or tromsoe or trondheim or levanger or gjovik or gjoevik or harstad or lillehammer or narvik or nesna or stord or haugesund or volda or aalesund or alesund)) or ((universitet* or University or univ) adj1 nord) or sentralsjukehus* or sentralsykehus* or Finnmarkssykehuset or Helgelandssykehuset or Nordlandssykehuset or innlandet or "Olav? Hospital?" or revmatismesykehus or lungesykehus or "Hospitalet Betanien" or Kysthospitalet or Aleris or Feiringklinikken or Glittreklinikken or "Hjertesenteret i Oslo" or "Medi 3" or "Volvat Medisinske Senter" or "Helse Vest" or "Helse Stavanger" or "Helse fonna" or "helse bergen" or "helse forde" or "helse foerde" or sjukehusapotek* or sykehusapotek* or "helse midt norge" or "helse midtnorge" or "Ambulanse Midtnorge" or "Ambulanse Midt norge" or "helse nord" or "Helse Sorost" or "Helse Sor ost" or "Helse Soeroest" or "Helse Soer oest" or sunnaas or sunnas or sorlandet or soerlandet).cp,in,tw,kf,pl. | 63669 |

| | | |
|---|---|---|
| 9 | (Akershus or Viken or Austagder or Agder or Buskerud or Finnmark or Hedmark or Hordaland or Romsdal or Nordland or Nordtrondelag or Trondelag or Nordtroendelag or Troendelag or Oppland or Oslo or Rogaland or Fjordane or Sortrondelag or Soertroendelag or Telemark or Troms or Vestagder or Vestfold or Ostfold or Oestfold or Longyearbyen or innlandet or vestland).cp,in,tw,kf,pl. | 106636 |
| 10 | (sjukhus* or centralsjukhus* or laenssjukhus* or lanssjukhus* or lansdelssjukhus* or laensdelssjukhus* or barnsjukhus* or ungdomssjukhus* or lasarett* or Regionsjukhus* or Narsjukhus* or Naersjukhus* or Specialistsjukhus* or Beckombergasykehuset or "Danvikens hospital" or Konradsberg or "karolinska institute?" or (karolinska adj2 hosp*) or ("astrid lindgren" adj2 hosp*) or sahlgrenska or Radiumhemmet or Sophiahemmet or Sodersjukhuset or Soedersjukhuset or Blekingesjukhuset or Anestesiklinik* or Linneuniversitetet or Mittuniversitetet or "Royal Institute of Technology" or ((Universitet* or universit* or univ) adj2 (norrland* or skaane? or skane? or lindkoping or orebro or lindkoeping or oerebro or lund or lunds or uppsala or gothenborg? or gothenburg? or goteborg? or goteburg? or goethenborg? or goethenburg? or goeteborg? or goeteburg? or umeaa? or umea? or luleaa or lulea or karlstad? or vaxjo or vaexjo or vaxjoe or vaexjoe or kalmar or tekniska or Linnaeus or Chalmers or malmo or malmoe or Malardalen? or Maelardalen? or karolinska))).cp,in,tw,kf,pl. | 341734 |
| 11 | (Blekinge or dalarna? or gotland or gavleborg? or gaevleborg? or halland or jamtland* or jaemtland* or jonkoping? or joenkoping? or kalmar? or kronoberg? or norbotten or skaane or skane or stockholm? or sodermanland? or soedermanland? or uppsala? or varmland? or vaermland? or vasterbotten? or vaesterbotten? or vasternorrland? or vaesternorrland? or vastmanland? or vaestmanland? or gotaland? or orebro? or "oster gotland?" or goetaland? or oerebro? or "oester gotland?").cp,in,tw,kf,pl. | 251961 |
| 12 | (sygehus* or ((Universitet* or universit* or hospital* or hosp) adj3 (amager* or Augustenborg* or Bornholm* or farso* or give or herning* or hobro* or koge or koege or oringe* or randers or ringsted* or skagen* or "sct. hans*" or tarm or tonder* or toender* or thisted* or vejle* or viborg* or Aalborg* or aarhus* or Alborg* or arhus*)) or Specialhospital* or Universitetshospital* or Regionshospital* or "Psykiatrisk Cent*" or "Psykoterapeutisk Cent*" or Psykiatricenter* or Kommunehospital* or Centralsygeh* or "Hammel Neurocenter*" or "Vest Ribe*" or Aabenraa* or Abenra* or Aeroskobing* or Aroskobing* or Aeroeskobing* or Aroeskobing* or allerup* or Bispebjerg* or Bronderslev* or Broenderslev* or copenhagen* or Esbjerg* or Fakse or Fredericia* or Frederiksberg* or frederikshavn* or Gentofte* or Glostrup* or Grenaa* or Grena* or Grindsted* or Haderslev* or Herlev* or Hjorring* or Hjoerring* or holbaek* or Holbak* or Holstebro* or Horsens* or hovedstaden* or Hvidovre* or Kalundborg* or kobenhavn* or koebenhavn* or Kolding* or Korsor* or Korsoer* or Lemvig* or Middelfart* or Midtjylland* or | 271401 |

| | | |
|---|---|---|
| | Naestved* or Nakskov* or Nastved* or Nordjylland* or Nordsjaelland* or Nordsjalland* or Nykobing* or Nykoebing* or Odense* or Poppelhus* or Rigshospitalet* or Ringkobing* or Ringkoebing* or Risskov* or Roskilde* or Silkeborg* or Sjaelland* or Sjalland* or Skanderborg* or Skejby* or Slagelse* or Sonderborg* or Soenderborg* or Stolpegaard* or Svendborg* or Syddanmark* or sydvestjysk* or Syddansk* or "Tekniske Universitet*" or "IT Universitetet*" or ITUniversitetet* or "aarhus univ*" or "aalborg univ*" or "U of Aarhus*" or "U of aalborg*" or "Univ of Aarhus*" or "Univ of aalborg*" or "arhus univ*" or "alborg univ*" or "U of Arhus*" or "U of alborg*" or "Univ of Arhus*" or "Univ of alborg*").tw,cp,in,kf,pl. | |
| 13 | (tidsskrift for den norske laegeforening or lakartidningen or ugeskrift for laeger).jn. | 110949 |
| 14 | or/6-13 | 4178144 |
| 15 | 5 and 14 | 208 |
| 16 | limit 15 to yr="2012 -Current" | 147 |

**Database:** **Embase <1974 to 2024 August 30>**

**Date:** September 2 2024

**Number of hits:** 101

| | | |
|---|---|---|
| 1 | vancomycin resistant Enterococcus/ | 7779 |
| 2 | (((vancomycin or VAN or linezolid) adj resistant enterococc*) or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) adj2 enterococc*)).tw,kf. | 8279 |
| 3 | 1 or 2 | 11154 |
| 4 | (colonis* or coloniz* or carrier? or screening?).tw,kf. | 1484684 |
| 5 | 3 and 4 | 2731 |
| 6 | limit 5 to (conference abstracts or embase or "preprints (unpublished, non-peer reviewed)") | 2528 |
| 7 | exp scandinavia/ or exp north germanic people/ or Netherlands/ | 331688 |
| 8 | (Scandinavi* or nordic or Norway or norwegian? or Norge or Svalbard or Spitsbergen or Jan Mayen or Sweden or swedish or swede? or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* | 2620287 |

| | | |
|---|---|---|
| | or "Fa?roe Islands" or fa?roes* or Greenland or Kalaallit Nunaat or Netherland* or Holland).in,ad,tw,lg,kf. | |
| 9 | (sykehus* or sjukehus* or ((universitet* or University or univ) adj3 (haukeland or nordnorge or norge* or bergen or stavanger or tromso or tromsoe or trondheim or levanger or gjovik or gjoevik or harstad or lillehammer or narvik or nesna or stord or haugesund or volda or aalesund or alesund)) or ((universitet* or University or univ) adj1 nord) or sentralsjukehus* or sentralsykehus* or Finnmarkssykehuset or Helgelandssykehuset or Nordlandssykehuset or innlandet or "Olav? Hospital?" or revmatismesykehus or lungesykehus or "Hospitalet Betanien" or Kysthospitalet or Aleris or Feiringklinikken or Glittreklinikken or "Hjertesenteret i Oslo" or "Medi 3" or "Volvat Medisinske Senter" or "Helse Vest" or "Helse Stavanger" or "Helse fonna" or "helse bergen" or "helse forde" or "helse foerde" or sjukehusapotek* or sykehusapotek* or "helse midt norge" or "helse midtnorge" or "Ambulanse Midtnorge" or "Ambulanse Midt norge" or "helse nord" or "Helse Sorost" or "Helse Sor ost" or "Helse Soeroest" or "Helse Soer oest" or sunnaas or sunnas or sorlandet or soerlandet).in,ad,ti,ab,kf. | 94104 |
| 10 | (Akershus or Viken or Austagder or Agder or Buskerud or Finnmark or Hedmark or Hordaland or Romsdal or Nordland or Nordtrondelag or Trondelag or Nordtroendelag or Troendelag or Oppland or Oslo or Rogaland or Fjordane or Sortrondelag or Soertroendelag or Telemark or Troms or Vestagder or Vestfold or Ostfold or Oestfold or Longyearbyen or innlandet or vestland).in,ad,ti,ab,kf. | 159156 |
| 11 | (oslonorway or bergennorway or sandnesnorway or stavangernorway or trondheimnorway or tromsonorway or tromsoenorway or Akershusnorway or Vikennorway or Austagdernorway or Agdernorway or Buskerudnorway or Finnmarknorway or Hedmarknorway or Hordalandnorway or Romsdalnorway or Nordlandnorway or Nordtrondelagnorway or Nordtroendelagnorway or Trondelagnorway or Troendelagnorway or Opplandnorway or Rogalandnorway or Fjordanenorway or Sortrondelagnorway or Sortroendelagnorway or Telemarknorway or Tromsnorway or Vestagdernorway or Vestfoldnorway or Ostfoldnorway or Oestfoldnorway or innlandetnorway or vestlandnorway).in,ad,ti,ab,kf. | 746 |

| | | |
|---|---|---|
| 12 | (sjukhus* or centralsjukhus* or laenssjukhus* or lanssjukhus* or lansdelssjukhus* or laensdelssjukhus* or barnsjukhus* or ungdomssjukhus* or lasarett* or Regionsjukhus* or Narsjukhus* or Naersjukhus* or Specialistsjukhus* or Beckombergasykehuset or "Danvikens hospital" or Konradsberg or "karolinska institute?" or (karolinska adj2 hosp*) or ("astrid lindgren" adj2 hosp*) or sahlgrenska or Radiumhemmet or Sophiahemmet or Sodersjukhuset or Soedersjukhuset or Blekingesjukhuset or Anestesiklinik* or Linneuniversitetet or Mittuniversitetet or "Royal Institute of Technology" or ((Universitet* or universit* or univ) adj2 (norrland* or skaane? or skane? or lindkoping or orebro or lindkoeping or oerebro or lund or lunds or uppsala or gothenborg? or gothenburg? or goteborg? or goteburg? or goethenborg? or goethenburg? or goeteborg? or goeteburg? or umeaa? or umea? or luleaa or lulea or karlstad? or vaxjo or vaexjo or vaxjoe or vaexjoe or kalmar or tekniska or Linnaeus or Chalmers or malmo or malmoe or Malardalen? or Maelardalen? or karolinska))).in,ad,ti,ab,kf. | 491817 |
| 13 | (Blekinge or dalarna? or gotland or gavleborg? or gaevleborg? or halland or jamtland* or jaemtland* or jonkoping? or joenkoping? or kalmar? or kronoberg? or norbotten or skaane or skane or stockholm? or sodermanland? or soedermanland? or uppsala? or varmland? or vaermland? or vasterbotten? or vaesterbotten? or vasternorrland? or vaesternorrland? or vastmanland? or vaestmanland? or gotaland? or orebro? or "oster gotland?" or goetaland? or oerebro? or "oester gotland?").in,ad,ti,ab,kf. | 374819 |
| 14 | (norrlandsweden or skaanesweden or skanesweden or lindkopingsweden or lindkoepingsweden or orebrosweden or oerebrosweden or lundsweden or uppsalasweden or gothenborgsweden or gothenburgsweden or goteborgsweden or goteburgsweden or goethenborgsweden or goethenburgsweden or goeteborgsweden or goeteburgsweden or umeaasweden or umeasweden or luleaasweden or luleasweden or karlstadsweden or vaxjosweden or vaexjosweden or vaxjoesweden or vaexjoesweden or kalmarsweden or malmosweden or malmoesweden or Malardalensweden or Maelardalensweden or Blekingesweden or dalarnasweden or gotlandsweden or gavleborgsweden or gaevleborgsweden or hallandsweden or jamtlandsweden or jaemtlandsweden or jonkopingsweden or joenkopingsweden or kalmarsweden or kronobergsweden or norbottensweden or stockholmsweden or sodermanlandsweden or soedermanlandsweden or uppsalasweden or varmlandsweden or vaermlandsweden or vasterbottensweden or | 2131 |

| | | |
|---|---|---|
| | vaesterbottensweden or vasternorrlandsweden or vaesternorrlandsweden or vastmanlandsweden or vaestmanlandsweden or gotalandsweden or goetalandsweden or orebrosweden or oerebrosweden or gotlandsweden or Vasteraassweden or Vaesterassweden or helsingborgsweden or norrkopingsweden or norrkoepingsweden).in,ad,ti,ab,kf. | |
| 15 | (sygehus* or ((Universitet* or universit* or hospital* or hosp) adj3 (amager* or Augustenborg* or Bornholm* or farso* or give or herning* or hobro* or koge or koege or oringe* or randers or ringsted* or skagen* or "sct. hans*" or tarm or tonder* or toender* or thisted* or vejle* or viborg* or Aalborg* or aarhus* or Alborg* or arhus*)) or Specialhospital* or Universitetshospital* or Regionshospital* or "Psykiatrisk Cent*" or "Psykoterapeutisk Cent*" or Psykiatricenter* or Kommunehospital* or Centralsygeh* or "Hammel Neurocenter*" or "Vest Ribe*" or Aabenraa* or Abenra* or Aeroskobing* or Aroskobing* or Aeroeskobing* or Aroeskobing* or allerup* or Bispebjerg* or Bronderslev* or Broenderslev* or copenhagen* or Esbjerg* or Fakse or Fredericia* or Frederiksberg* or frederikshavn* or Gentofte* or Glostrup* or Grenaa* or Grena* or Grindsted* or Haderslev* or Herlev* or Hjorring* or Hjoerring* or holbaek* or Holbak* or Holstebro* or Horsens* or hovedstaden* or Hvidovre* or Kalundborg* or kobenhavn* or koebenhavn* or Kolding* or Korsor* or Korsoer* or Lemvig* or Middelfart* or Midtjylland* or Naestved* or Nakskov* or Nastved* or Nordjylland* or Nordsjaelland* or Nordsjalland* or Nykobing* or Nykoebing* or Odense* or Poppelhus* or Rigshospitalet* or Ringkobing* or Ringkoebing* or Risskov* or Roskilde* or Silkeborg* or Sjaelland* or Sjalland* or Skanderborg* or Skejby* or Slagelse* or Sonderborg* or Soenderborg* or Stolpegaard* or Svendborg* or Syddanmark* or sydvestjysk* or Syddansk* or "Tekniske Universitet*" or "IT Universitetet*" or ITUniversitetet* or "aarhus univ*" or "aalborg univ*" or "U of Aarhus*" or "U of aalborg*" or "Univ of Aarhus*" or "Univ of aalborg*" or "arhus univ*" or "alborg univ*" or "U of Arhus*" or "U of alborg*" or "Univ of Arhus*" or "Univ of alborg*").in,ad,ti,ab,kf. | 404366 |

| | | |
|---|---|---|
| 16 | (amagerdenmark or Augustenborgdenmark or Bornholmdenmark or farsodenmark or farsoedenmark or givedenmark or herningdenmark or hobrodenmark or kogedenmark or koegedenmark or oringedenmark or randersdanmark or ringsteddenmark or tarmdenmark or thisteddenmark or tonderdenmark or toenderdenmark or Vejledanmark or viborgdenmark or Aalborgdenmark or aarhusdenmark or Alborgdenmark or arhusdenmark).in,ad,ti,ab,kf. | 333 |
| 17 | (tidsskrift for den norske laegeforening or tidsskrift for den norske laegeforening tidsskrift for praktisk or tidsskrift for den norske laegeforening tidsskrift for praktisk medicin ny raekke or Norsk Epidemiologi or lakartidningen or ugeskrift for laeger).jn. | 94906 |
| 18 | or/7-17 | 2679013 |
| 19 | 6 and 18 | 173 |
| 20 | limit 19 to yr="2012 -Current" | 101 |

**Database:** **Cochrane Central Register of Controlled Trials**

**Issue 11 of 12, November 2023**

**Date:** September 2 2024

**Number of hits:** 3 trials

| | | |
|---|---|---|
| #1 | [mh ^"Vancomycin-Resistant Enterococci"] | 28 |
| #2 | (((vancomycin or VAN or linezolid) NEXT ("resistant enterococci" or "resistant enterococcus")) or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) NEAR/2 enterococc*)):ti,ab | 196 |
| #3 | #1 or #2 | 199 |
| #4 | (colonis* or coloniz* or carrier? or screening?):ti,ab | 86942 |
| #5 | #3 and #4 | 95 |
| #6 | [mh "Scandinavian and Nordic Countries"] or [mh ^"Scandinavians and Nordic People"] or [mh Netherlands] | 13731 |
| #7 | (Scandinavi* or nordic or Norway or norwegian? or Norge or Svalbard or Spitsbergen or "Jan Mayen" or Sweden or swedish or swede? or Sverige or Denmark or danish or Danmark or Finland or finnish or finns or Aland or Aaland or alandi* or aalandi* or Suomi or Iceland or icelandic* or icelander* or "Faroe Islands" or "Faeroe Islands" or fa?roes* or Greenland or "Kalaallit Nunaat" or Netherland* or Holland or Dutch):ti,ab | 40724 |
| #8 | #6 or #7 | 46021 |
| #9 | #5 and #8 | 4 |

| | | |
|---|---|---|
| #10 | #9 with Publication Year from 2012 to 2024, in Trials | 3 |

**Database:** **Web of Science Core Collection**

**- WOS.SCI: 1987 to 2024**

**- WOS.AHCI: 1987 to 2024**

**- WOS.ESCI: 2018 to 2024**

**- WOS.SSCI: 1987 to 2024**

**Date:** September 2 2024

**Number of hits:** 84

| | | | |
|---|---|---|---|
| 1 | TS=(((vancomycin or VAN or linezolid) NEAR/0 "resistant enterococc*") or (("VAN−R" or VRE or vancomycinresistan* or linezolidresistan* or LRE) NEAR/1 enterococc*)) | Exact search | 7323 |
| 2 | TS=(colonis* or coloniz* or carrier$ or screening$) | Exact search | 1596630 |
| 3 | #1 AND #2 | Exact search | 2170 |
| 4 | #3 AND (CU==("NORWAY" OR "SWEDEN" OR "DENMARK" OR "FINLAND" OR "ICELAND" OR "NETHERLANDS")) | Exact search | 155 |
| 6 | #4<br>Timespan: 2012-01-01 to 2024-09-02 | Exact search | 84 |

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Norwegian Institute of Public Health

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