

Interim Advice for the Diagnosis and Management of PVL-associated *Staphylococcus aureus* infections (PVL-*S. aureus*)

Scottish Recommendations

May 2014

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Abbreviations

BNF	British National Formulary
BNFc	British National Formulary for children
CA	Community Acquired
CA-MRSA	Community-associated meticillin-resistant <i>Staphylococcus aureus</i>
CRP	C- Reactive Protein
ESR	Erythrocyte Sedimentation Rate
GDG	Guideline Development Group
GP	General Practitioner
HA-MRSA	Hospital-associated meticillin-resistant <i>Staphylococcus aureus</i>
HCW	Healthcare worker
HPA	Health Protection Agency
HPS	Health Protection Scotland
HPT	Health Protection Team
ICT	Infection Control Team
IPC	Infection Prevention Control
IMT	Incident Management Team
IV	Intravenous
IVIG	Intravenous immunoglobulin
MRSA	Meticillin-resistant <i>Staphylococcus aureus</i>
MSSA	Meticillin-sensitive <i>Staphylococcus aureus</i>
PAG	Problem Assessment Groups
PHE	Public Health England
PVL	Panton-Valentine Leukocidin
SA	<i>Staphylococcus aureus</i>
SICP	Standard Infection Control Precautions
SSTI	Skin and soft tissue infection
RCPI	Royal College of Physicians of Ireland
TSS	Toxic shock syndrome
TBP	Transmission Based Precautions
TSA	Toxigenic <i>Staphylococcus aureus</i>

1. About this Document

The recommendations in this document have been produced by the PVL Working Group – Guideline Development Group (GDG) (see [section Appendix D: Guideline Development Group \(GDG\) Membership on page 34](#)) convened in 2012, at the request of the Scottish Health Protection Network (HPN) Steering Group.

- This document aims to provide advice based on best available evidence where it exists (otherwise expert consensus opinion), on the recognition, investigation and management of PVL *Staphylococcus aureus* (PVL-*S. aureus*) cases in Scotland. It aims to assist all healthcare professionals who are involved in the management of these patients, from Primary Care to Public Health.
- This document is based on the HPA ‘Guidance on the Diagnosis and Management of PVL-associated *Staphylococcus aureus* infections’ (HPA, 2008) and some sections have been reproduced with permission from Public Health England (PHE).
- In 2011, the HPN commissioned the appraisal of the HPA 2008 document to independent external reviewers. The outcome of that appraisal (using the AGREE Instrument, 2009), as well as a subsequent review of the literature published before October 2012, further informed the GDG, who in the last year extensively consulted key partners and experts in the field.
- Recommendations given in this guidance are the result of careful review and consideration of the evidence available, existing guidance, expert opinion and principles of best practice.
- Public Health England (PHE) is currently, at the time this has been published, reviewing their 2008 guidance. As developments in the field have occurred, it has become apparent that advice is required not only for the management of PVL-*S. aureus* but for that of a wider suite of virulence determinants for *Staphylococcus aureus* and their resultant clinical syndromes. The UK GDG, therefore, has an overall aim of producing UK-wide evidence-based clinical guidance on the prevention and management of toxigenic *Staphylococcus aureus* (TSA) infections, excluding enterotoxigenic disease.
- The Health Protection Network (HPN) is represented at the UK guideline development group. Therefore, this document is an interim document that will provide advice for Scotland, while the UK group works on a more systematic approach to review the updated evidence. The HPN will review the recommendations proposed by the UK group and decide on the most appropriate advice for Scotland.

Professional Judgement and Compliance to this Document

Professionals involved in the investigation and management of PVL-*S. aureus* infections in Scotland are expected to take this guidance document fully into account when exercising their professional judgment. The document does not, however, override the individual responsibility of professionals to make decisions appropriate to the circumstances of the individual incidents and cases, in consultation with partner agencies and stakeholders. Implementation of this guidance is the responsibility of the health protection community across Scotland. Professionals are reminded that it is their responsibility to implement the recommendations provided, in their local context, in light of their duties to avoid unlawful discrimination and to have regard to promoting equality of opportunity. Nothing in this guidance should therefore be interpreted in a way which would be inconsistent with compliance with those duties.

Comments on the Published Guidance

Comments on this document should be sent to the HPN Steering Group via its national coordinator or administration, submitting the form available at the <http://www.hps.scot.nhs.uk/about/guidancedevelopment.aspx>, to the following email address NSS.HPN@nhs.net. A copy of this form is also available in **Appendix E**.

Sometimes a comment after publication may highlight a potential error in clinical guidance. This might be in either the interpretation or the presentation of the evidence considered by the GDG. In these cases the Chair of the Health Protection Network and the advisors they approach will consider whether the potential error:

- may result in harm to patients/the population;
- undermines the conclusions on which the recommendations were based;
- indicates serious problems with our quality-assurance procedures.

If one of these criteria is met, the comment will be referred to the HPN Guidance Executive, which decides what action to take. If the Guidance Executive does not accept that an error has been made, the individual or organisation that made the comment will be notified. If the Guidance Executive accepts that an error has been made, a note will be put on our website, and the versions of the document on the website will be amended. Depending on the nature and significance of the error and the time since publication, registered stakeholders may also be notified in writing.

Comments or new evidence which do not relate to an error will be collated and considered at the time when review of the document is due.

Review and Update

This document should be reviewed in 3 years or when the UK national guidance becomes available, whichever is sooner. It is envisaged that the HPN will oversee this process.

2. Background and Epidemiology

Panton-Valentine Leuocidin (PVL) is a cytotoxin that destroys white blood cells and is produced by some strains of *Staphylococcus aureus* (Etienne and Dumitrescu, 2009).

PVL takes its name from two authors who first published a paper in 1932 (Panton, 1932) and is encoded by two genes luk-S-PV and luk-F-PV. PVL is transferred by bacteriophages in some heterogeneous strains of Meticillin-Resistant *Staphylococcus aureus* (MRSA) and Meticillin-Sensitive *Staphylococcus aureus* (MSSA). It should be noted that terminology is changing and PVL has also been referred to under the name Toxigenic *Staphylococcus aureus* (TSA).

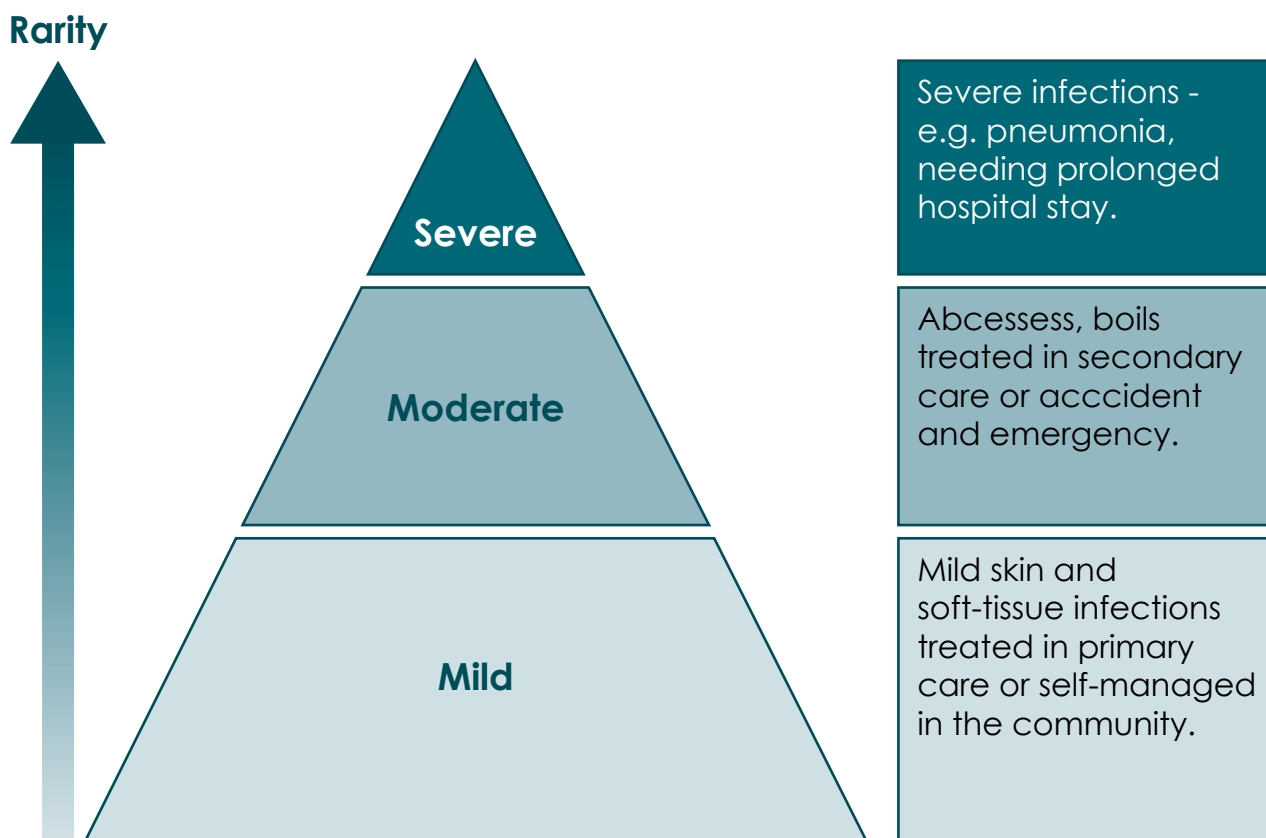
There is currently a lack of robust evidence on prevalence and incidence of PVL *S. aureus* infection (Coia *et al*, 2006). However, over the last decade, there have been multiple case reports from the UK, Europe, USA and Asia of patients with various forms of the disease, indicating that PVL-*S. aureus* is on the increase (Ellington MJ *et al*, 2009; Koch R, 2010; Nhan TX *et al*, 2012).

The increase in morbidity and mortality associated with PVL-MRSA has caused public health concern worldwide. To date most PVL-*S. aureus* strains in the UK have been MSSA, but a major problem has emerged with Community Acquired MRSA (CAMRSA) in North America, most of which produce PVL. One strain in particular, the USA300 clone, is now spreading in hospitals in the USA (Patel, 2008).

PVL-*S. aureus* infections, although currently uncommon in the UK, seem to have increased in the last few years. It is not clear, however, whether the increasing numbers observed reflect improved case ascertainment of PVL-related syndromes and/or an increasing real prevalence of PVL-*S. aureus*.

From a UK perspective, fatalities due to PVL-*S. aureus*, although rare, and seen in both community and healthcare settings, have attracted high-profile media attention and prompted concern regarding the transmissibility and virulence sometimes associated with these organisms ([Figure 1](#)). PVL-*S. aureus* has emerging epidemiology so this document is based on literature up to and including October 2012. Further details on epidemiology in Scotland can be accessed via the Scottish MRSA Reference Laboratory and/or Health Protection Scotland (HPS).

FIGURE 1: Clinical iceberg of Panton-Valentine leucocidin-associated infection - with permission from Shallcross LJ *et al* (2013)



3. Clinical features and Diagnosis of PVL-*S. aureus* Infections

PVL-*S. aureus* predominantly cause skin and soft tissue infections (SSTI) (Rajendran PM, 2007), but can also cause invasive infections (Morgan, 2007), the most serious of these is a necrotising haemorrhagic pneumonia with a high mortality (Gillet Y, 2002). This often follows a 'flu-like' illness, and may affect otherwise healthy young people in the community as well as those of any age with underlying conditions that may predispose them to staphylococcal infection. The clinical presentation of PVL-*S. aureus* infection is summarised in table 1.

TABLE 1: Clinical presentation of PVL-*S. aureus* infections.

Skin and soft tissue infections (SSTI)	Invasive infections
<p>These are often recurrent and include:</p> <ul style="list-style-type: none"> • Boils (furunculosis), carbuncles, folliculitis, cellulitis, purulent eyelid infection • Tissue necrosis • Abscesses <p>Fogo A, Kemp N, Morris-Jones R (2011)</p>	<ul style="list-style-type: none"> • Necrotising pneumonia (McGrath B, 2008) • Necrotising fasciitis • Osteomyelitis, septic arthritis, and pyomyositis • Purpura fulminans • Bacteraemia

In addition to the clinical presentation (as above), PVL-*S. aureus* **infections should be suspected:**

- when there are clusters of skin or soft tissue infections within a household or social group;
- when community-acquired necrotising/haemorrhagic pneumonia presents in young, previously fit people.

PVL infections in children are associated (in particular) **with:**

- enhanced inflammatory response (higher ESR and C-reactive protein (CRP));
- local disease (myositis/pyomyositis) and multiple site/recurrent furunculosis;
- severe sepsis that may present with purpura fulminans and/or deep vein thrombosis;
- pneumonia that may present with preceding 'flu-like' illness; haemoptysis, leuco/neutropenia and multilobular infiltrates;
- acute haematogenous osteomyelitis or osteoarticular infections (Bocchini EC, Hulten KG, *et al*, 2006).

3.1 Diagnosis of Patients with Community-Acquired (CA) Necrotising Pneumonia

Early clinical diagnosis is difficult but essential for improving survival. A household history of spreading or recurrent PVL-*S. aureus* skin sepsis may also be present (Morgan, 2007). **Table 4** provides a summary of the clinical parameters that may help identify community acquired (CA) necrotising pneumonia.

TABLE 2: Clinical parameters for the diagnosis of community acquired (CA) necrotising pneumonia.

Clinical signs	Radiography	Clinical and Diagnostic Parameters
<p>Pneumonia and sepsis in a previously fit young patient following a 'flu-like' illness warrant prompt referral to hospital if the following features are present:</p> <ul style="list-style-type: none"> • Airway bleeding/ haemoptysis; • Hypotension; • Tachycardia >140 beats/min, diarrhoea and vomiting (may be due to associated toxic shock). 	<ul style="list-style-type: none"> • Multilobular infiltrates on chest X-ray, usually accompanied by effusions and later cavitation. 	<ul style="list-style-type: none"> • Gram film of sputum reveals numerous Gram-positive cocci in grapelike clusters; • Marked leucopenia (may be within normal limits early in illness as destruction by toxins is just beginning); • Very high CRP level (>200g/L: unusual in viral infections); • Negative Pneumococcal and Legionella antigen tests; • Significantly raised serum creatine kinase (suggests myositis); • Usual investigation blood cultures, viral testing, skin swabs etc to be taken.

3.2 Risk Factors for PVL-*S. aureus* Infections Transmission

The risk factors for PVL-*S. aureus* transmission between individuals include: people in close contact (direct or indirect contact - via fomites).

The following settings may have higher risk for transmission from an individual colonised or infected with these staphylococci:

- household and sexual contacts;
- contacts in social/sports settings - e.g. wrestling, American football, rugby, judo;
- closed community settings: - e.g. military camps, gyms, prisons;
- carehomes and healthcare settings (hospital wards).

4. Microbiological Samples and PVL Testing

Clinical staff in primary and acute care settings should be alert to the importance of:

- further investigating suspected necrotising pneumonia (co-infection with a respiratory virus, including influenza);
- **taking samples for culture and PVL toxin testing**, when incising and draining multiple and recurring abscesses – as well as other samples as appropriate (e.g. blood cultures, swabs of pus, sputum, nasopharyngeal aspirate, etc);
- giving sufficient clinical details to enable laboratory staff to select any staphylococci for further testing; and
- discussing any clinical concerns with local Microbiologist or Infectious Disease Doctor.

4.1 PVL Testing in SMRSARL

In case of queries, the local Microbiology department can ask for advice from the Scottish MRSA Reference laboratory (SMRSARL) (contact details at <http://www.smrsarl.scot.nhs.uk/>):

- MSSA or MRSA isolated from PVL suspected cases should be referred to SMRSARL for toxin gene profiling, which includes PVL testing.
- **All staphylococci from blood cultures are tested for PVL.** This PCR-based assay is performed daily and completed within a working day. If results are needed urgently, these will be telephoned to the submitting laboratory if a request is made. Even if PVL testing is performed locally, isolates must be sent to SMRSARL for further toxin testing and typing, as this is currently the basis of national surveillance and provides early warning of changes in the national situation.

MRSAs with a typical susceptibility pattern for hospital type MRSAs and likely to have been acquired in a healthcare setting should not be referred unless clinical history suggests a PVL-*S. aureus* infection, e.g. necrotising pneumonia, recurrent boils etc. This information must be included on the referral forms. Ciprofloxacin-resistant MRSA should not be referred for PVL testing unless they are associated with typical PVL-*S. aureus* related disease.

5. Management of Suspected and Confirmed PVL-*S. aureus* Cases

5.1 Antibiotic Treatment of Suspected and Confirmed PVL-*S. aureus* Infections in Adults (see [section 5.2 on page 14](#) for the management of children)

The following pattern should be adopted to treat suspected and confirmed PVL *S. aureus* infections in adults:

- Consult with the local Microbiologist;
- Consult any local antibiotic prescribing policies;
- Modify antibiotic choice, once sensitivity results are available.
- Inform local Infection Prevention and Control Team if the patient requires admission to hospital to ensure appropriate Transmission Based Precautions (TBPs) are put in place. (see [section 8. Infection Prevention and Control \(IPC\) Measures on page 20](#). [Table 3](#) indicates generic advice in relation to the antibiotic treatment of suspected and confirmed infected adults. This advice should be considered in conjunction with risk assessment of each individual case and appropriate clinical judgement.

It should be noted that there are few robust clinical data on which to provide clear antimicrobial recommendations. The advice in [Table 3](#) reflects current experience, case reports and in vitro experimental data.

Current thinking is that flucloxacillin should be avoided in treatment of severe infections (even in combination with other antimicrobials or as high doses) as sub-inhibitory concentrations may enhance toxin production. In this situation, antimicrobials such as clindamycin or linezolid have the advantage of suppressing toxin production.

TABLE 3: Antibiotic Treatment of Suspected and Confirmed PVL-*S. aureus* Infections in Adults (see [section Table 4 on page 15](#) for children).

Indications	Antimicrobial choice	Comments
<p>Non-suppurative minor skin and soft tissue. Including furunculosis, folliculitis, small abscesses/boils without cellulitis.</p> <p>PVL - MRSA not suspected.</p>	<ul style="list-style-type: none"> Flucloxacillin orally if required 	<p>Does not need systemic antibiotic treatment unless the patient is immunocompromised, or deteriorating clinically.</p> <p>Incision and drainage is the optimal management for abscesses.</p> <p>Lesions should be covered.</p> <p>Advise good personal hygiene, in particular hand washing. Avoid sharing towels, cloths, personal care items.</p> <p>Patients should be advised to return to GP if the lesions do not resolve or there is clinical deterioration.</p>
<p>Moderate infections including cellulitis and larger abscesses (especially those > 5cm).</p> <p>PVL - MRSA not suspected.</p>	<ul style="list-style-type: none"> Flucloxacillin <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> Clindamycin OR Doxycycline <p>Cotrimoxazole may also be used for penicillin allergic patients</p>	<p>Incision and drainage is the optimal management for abscesses.</p> <p>Note <i>C. difficile</i> risk with use of clindamycin.</p> <p>Review with laboratory antibiotic results when available.</p>
<p>When PVL-MRSA is suspected but not confirmed and hospital admission is not warranted.</p> <p>Liu C (2011) De Angelis G (2011) (*) Nathwani D (2008)</p>	<ul style="list-style-type: none"> Doxycycline (not for children <12 y) <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> Rifampicin PLUS Sodium Fusidate OR rifampicin PLUS trimethoprim <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> Clindamycin 	<p>Resistance to Rifampicin and Fusidic acid may develop during treatment and these should not be used as single agents.</p> <p>Review with laboratory antibiotic results when available.</p> <p>Linezolid maybe available on advice from local Microbiologists or Infectious Disease Doctors.</p>

Indications	Antimicrobial choice	Comments
<p>PVL- MRSA confirmed</p>	<p>Treatment guided by antimicrobial susceptibility tests and local policy</p>	<p>Provide information to the patient – Patient Information leaflet (section Appendix B on page 31 and section Appendix C on page 32).</p>
<p>In severe infections with features of toxic shock, necrotising fasciitis or purpura fulminans.</p> <p>Seek specialist advice from microbiology, infectious diseases, medical and surgical specialties as appropriate.</p>	<p>Refer to hospital</p> <p>There may be a theoretical case for using two agents such as these agents suppress toxin production:</p> <ul style="list-style-type: none"> Linezolid combined WITH Clindamycin (high dose). 	<p>Treatment should be continued for 10-14 days until the patient has improved and is clinically stable.</p> <p>Seek specialist advice from Microbiology or Infectious Diseases Team.</p> <p>Consult BNF for details on use of these antibiotics.</p> <p>Early surgical debridement of infected tissue where appropriate.</p> <p>Evidence from <i>in-vitro</i> synergy and the ability of linezolid and clindamycin to suppress PVL and alpha toxin production.</p> <p>Consider use of IV immunoglobulin using local protocols.</p> <p>Although bactericidal, there are concerns that at concentrations just above the minimum inhibitory concentration (likely with poor penetration into necrotic tissue) flucloxacillin may increase PVL production as it does <i>in-vitro</i> (Stevens et al, 2007).</p> <p>Intravenous flucloxacillin is not recommended, even in combinations with agents such as rifampicin or clindamycin.</p>

Indications	Antimicrobial choice	Comments
<p>In suspected community-acquired (CA) PVL-related pneumonia.</p> <p>Note: standard empiric antimicrobial cover for non staphylococcal pathogens may be required until microbiology results are available.</p>	<p>Start empiric antibiotics covering MRSA – linezolid and high dose of clindamycin.</p> <p>AND if deteriorating or features of severe disease (e.g. septic shock) add IVIG 2g/kg + rifampicin 600 mg bd.</p>	<p>Continue empiric antibiotic therapy for 48-72 hours or until culture results are available when targeted therapy can be consolidated:</p> <ul style="list-style-type: none"> • Seek advice from local Microbiologists or Infectious Disease Doctors. • There is evidence that the use of rifampicin and linezolid combined may reduce blood concentration of linezolid. <p>If no clinical improvements and increasing failure to ventilate:</p> <ul style="list-style-type: none"> • Exclude complications (e.g. abscess, empyema) and no infections – consider second dose of IVIG. • Re-evaluate for infection with antibiotic-resistant pathogen not covered by initial antimicrobial regimen.
<p>In case of deep-seated infections (e.g. Osteomyelitis/disciitis)</p>	<p>Seek specialist advice</p>	<p>Seek specialist advice</p>

*<http://jac.oxfordjournals.org/content/61/5/976.full>

Table 3 should be followed in line with the following advice:

- Please consult BNF for adults (<http://www.medicinescomplete.com/mc/bnf/current/PHP3256-antibacterial-drugs.htm>) for advice on dose and dosage modifications if required with weight, renal and hepatic function, interactions and contraindications.
- Consult BNF for details on adverse and toxic events and monitoring requirements.
- Standard Infection Control Precautions must continue to be applied and additional TBPs considered and implemented as set out in the National Infection Prevention and Control Manual: <http://www.hps.scot.nhs.uk/haic/ic/nationalinfectionpreventionandcontrolmanual.aspx>.

5.2 Special Consideration Around the Management of Confirmed and Suspected PVL-*S. aureus* Infections in Children

- Please consult BNF for Children for contraindications and precautions in the use of these antibiotics: <http://www.medicinescomplete.com/mc/bnfc/current/PHP12608-infections.htm>.

Skin and soft tissue infections in children:

- These should be suspected if there are recurrent boils or abscesses or a close contact who has skin lesions.

Initial approach to therapy of deep-seated infections in children:

- Administer antibiotics according to local guidelines for empirical management of infections, but add clindamycin if PVL-MSSA is suspected. Linezolid can be used after discussion with Microbiologist or Infectious Disease Doctor;
- Close monitoring of clinical condition is essential, as some patients will deteriorate even after several days receiving appropriate antibiotic therapy;
- Ensure appropriate consultation, for instance with Medical Microbiologist, paediatric Infectious Disease Doctor, Orthopaedic Surgeon or Haematologist, as required. If patient admitted to hospital, inform Infection Prevention and Control Team so that appropriate measures are put in place.
- For the management of deep-seated infections in children, follow [Table 4](#).

TABLE 4: Management of deep-seated infections in Children

Type of Illness	Indicators and Management
Abscesses	<ul style="list-style-type: none"> Localised abscesses (e.g. retropharyngeal or in lymph nodes) may be associated with local venous thrombosis, very high CRP and patient or close family contact has current, or a history of, recurrent boils/abscesses or skin infections.
Bone and joint infections	<ul style="list-style-type: none"> Suspect if patient or close family contact has current, or a history of, recurrent boils/abscesses or skin infections or there is severe sepsis, multiple sites of infection/abscesses, extensive local lesions, myositis/pyomyositis, local venous thrombosis, very high CRP and a need for repeated surgical intervention. Aggressive approach to drainage of foci of infection. Once infection with PVL-<i>S. aureus</i> is confirmed, use intravenous clindamycin (if susceptible) plus rifampicin, and consider use of linezolid or an alternative combination advised by a specialist in paediatric infectious disease. Repeated surgical intervention for drainage may be required, and the duration of antibiotic treatment may need to be very prolonged. Use of linezolid may be particularly useful in bone and joint infections. Linezolid should be used for a maximum of four-weeks due to the risk of development of peripheral neuropathy. For all antibiotics use the maximum dosages listed in the British National Formulary for children (BNFc) - http://www.medicinescomplete.com/mc/bnfc/current/PHP12608-infections.htm.
Severe sepsis	<ul style="list-style-type: none"> Suspect if patient or close family contact has current, or a history of, recurrent boils/abscesses or skin infections, and there are bone or joint infection, necrotising pneumonia, deep venous thrombosis, purpura fulminans. consider transfer to paediatric ICU. consider 1-2g/kg IVIG and repeat lower dose after 24-48 hours if needed (see below) in addition to antibiotic treatment.
Pneumonia	<ul style="list-style-type: none"> Suspect if there is preceding 'flu-like' illness, haemoptysis, multilobular infiltrates, bone or joint infection, leucopenia/neutropenia or patient or close family contact has current, or a history of, recurrent boils/abscesses or skin infections. Consider transfer to paediatric ICU. Consider 1-2g/kg IVIG and repeat lower dose after 24-48 hours if needed (see below) in addition to antibiotic treatment.*

* Use of IVIG: an initial dose of 1-2g/kg IVIG may be used in children, with some experts preferring a lower dose to reduce the risk of hyperviscosity occurring. This lower dose may be repeated after 24-48 hours if there is no clinical improvement.

6. Screening and Decolonisation of Patients and their Close Contacts

6.1 Screening of Patients and their Close Contacts

There is no evidence to support routine screening of contacts of patients with PVL-*S. aureus* infections (Shallcross LJ 2011). Patients and their household/sexual contacts should have high awareness of the potential for spread of PVL-*S. aureus*-related infections within their contact group:

- If close contacts suffer from infections typical or suggestive of PVL they should be advised to consult their GP for treatment, especially if they work or reside in high risk areas (see [section 3.2 on page 8.](#)), i.e. carehomes, closed communities (barracks, prisons) or healthcare settings.
- The decision to start contact screening in the case of a PVL-*S. aureus* outbreak within a healthcare setting will be risk assessed by the local Infection Prevention and Control Team.
- If the decision made concludes that screening is required, local MRSA screening procedures can be utilised in terms of which carriage sites to sample and the type of swabs to take.

6.2 Decolonisation of Patients and Contacts

The aims of a (topical) decolonisation programme for any staphylococcal infection include:

- reducing bacterial load - for instance, pre-operatively;
- managing household outbreaks where recurrent infections in different household members has occurred;
- reducing the risk of infection in close contacts (household or sexual) of a case of necrotising pneumonia (start without delay); as well as
- interrupting transmission during clusters or outbreaks in 'closed' communities.
- reducing risk of onward transmission (e.g. healthcare workers (HCW), those in closed communities).

However, no data have been identified to date to support clinical or cost effectiveness of community-based screening and decolonisation for PVL strains (Shallcross LJ, 2013, 2011, Reilly, 2009).

It is important to observe that while decolonisation can be achieved temporarily, re-colonisation can occur relatively quickly. There is consistent evidence to demonstrate that two weeks after decolonisation, MRSA is undetectable in about 90% of those undertaking topical decolonisation regimens; at six months though, this drops to 30% (Ammerlaan HS, 2009).

With regards to resistance to topical decolonisation programmes, there are concerns about development of resistance to both chlorhexidine and mupirocin (Patel JB, 2009).

- Given the limited evidence, careful consideration should be given to risk, benefits and outcomes to individuals and wider community (family, ward, institution etc) before offering decolonisation to contacts.
- The decision to decolonise contacts with or without screening in the case of a PVL-*S. aureus* outbreak within a healthcare setting will be risk assessed by the local Incident Management Team (IMT).
- If the decision made concludes that decolonisation with or without screening is required, the local policy for MRSA decolonisation may be used
- If the decision is made to offer decolonisation to close contacts of index cases who may have had PVL infections, it is prudent to wait until infection has resolved before starting and then start all contacts simultaneously.
- **Decolonisation of neonates and children**, especially premature neonates, is more difficult and unstandardised. When required, nasal mupirocin may be used as may aqueous based antiseptic solutions, such as chlorhexidine. Octenisan has been used as an alternative to chlorhexidine, but this is now has a cosmetic licence and requires an individual risk assessment as the company cannot recommend its use in children under 3 years of age. This topical agent requires a contact time of at least one minute and may cause a temperature drop in neonates. Further advice will be available from local infection prevention and control staff.
- Patients should be given information leaflets for PVL ([Appendix C on page 32](#)) describing how to minimise cross-infection and general information about PVL. Decolonisation protocols are not included in this document as the local MRSA decolonisation protocols and patient information can be used. However, some supplementary information is available in [Appendix B on page 31](#).
- In patients with dermatological conditions it is important to seek dermatological opinions, if there are ongoing issues with skin integrity (Fogo, *et al* 2011).
- Advice from Human Resources and Occupational Health must be sought when dealing with screening or exclusion of staff from work, following current Scottish guidance. 'NHS HDL (2006)31 Healthcare Associated Infection (HAI): Human Resources Policy for Staff Screening during Incidents and Outbreaks' available at http://www.sehd.scot.nhs.uk/mels/HDL2006_31.pdf. The decision to screen and/or decolonise staff during a cluster or outbreak will be made by the local IMT.
- The need for rescreening post decolonisation is unclear, but local MRSA screening protocols can be used. It may be appropriate for those patients who are vulnerable to infection (e.g. dialysis patients) or those who pose a risk of onward transmission (healthcare workers, those in closed communities).

7. Clusters and Outbreaks of PVL-*S. aureus* Infections

Health Protection Teams (HPTs) should be informed of possible clusters or outbreaks of confirmed PVL-*S. aureus* infection if identified by clinical, laboratory or other healthcare professionals.

- HPTs will review the circumstances of each cluster/outbreak, and, as a multi-disciplinary team, will decide on the most appropriate response, using formats such as a Problem Assessment Group (PAG), with representatives including staff from the affected area, Microbiologists etc. and others as required. Please refer to the Scottish Government/HPN (2011) 'Management of Public Health Incidents: Guidance on the Roles and Responsibilities of NHS led Incident Management Teams' available at <http://www.scotland.gov.uk/Publications/2013/08/6455/downloads>.

Clusters and outbreaks can occur in:

- those involved in gyms or 'close contact' sports, such as wrestling and rugby (see [section 3.2 on page 8](#));
- a 'closed' community where there may be potential for onward transmission (e.g. prison, military camp, carehome, healthcare setting); as well as
- households.
- nursery schools, these will have to be managed in consultation with Health Protection Teams on a case by case basis.

However, paucity of epidemiological data means that it is not always possible to identify a community-based cluster or outbreak. Some HPTs may use postcode data to try and track potential household outbreaks.

In a healthcare setting such as a hospital, it may be easier to identify when there are more than two cases associated by place or time. In this situation, the local Infection Prevention and Control Team will undertake review and response (see [section 8 on page 20](#)).

- The National Infection Prevention and Control Manual provides guidance to all those involved in care provision and should be adopted for infection prevention and control practices and procedures.
- Standard Infection Control Precautions must continue to be applied and additional TBPs considered and implemented as set out in the National Infection Prevention and Control Manual: <http://www.hps.scot.nhs.uk/haic/ic/nationalinfectionpreventionandcontrolmanual.aspx>.

Further advice:

- RCPI Clinical Advisory Group on HCAI & AMR, Subgroup MRSA Guidelines
- Committee (April 2013). Eradication of MRSA carriage (decolonisation). In: The Control and Prevention of MRSA. [Online] Available from: <http://www.hpsc.ie/A-Z/MicrobiologyAntimicrobialResistance/EuropeanAntimicrobialResistanceSurveillanceSystemEARSS/ReferenceandEducationalResourceMaterial/SaureusMRSA/Guidance/File,14478,en.pdf> [Accessed 13 August 2013].
- Useful advice can be found in the recommendations given at the 'Guidelines for the control and prevention of Meticillin-resistant *Staphylococcus aureus* (MRSA) in healthcare facilities' (Coia, 2006).

For household outbreaks of infection, patients will be treated by their own GP. However, there may be situations where different GPs are caring for different members of the household and in this situation co-ordination of treatment and, if required, decolonisation should be attempted; as would be the case for households undergoing treatment for scabies etc.

Recommendation (for Research):

- **Consider enhanced surveillance programme for laboratory confirmed cases of PVL with a view to enhancing existing knowledge on epidemiology of this in Scotland.**

8. Infection Prevention and Control (IPC) Measures

8.1 Infection Prevention and Control Measures for Hospitalised Patients

Hospitals have policies and procedures which deal with MRSA and these are generally appropriate for the control of PVL-*S. aureus* cases and outbreaks.

- Standard Infection Control Precautions must continue to be applied and additional TBPs considered and implemented as set out in the National Infection Prevention and Control Manual: <http://www.hps.scot.nhs.uk/haiic/ic/nationalinfectionpreventionandcontrolmanual.aspx>.

During an outbreak investigation, the following tools are available:

- The 'Hospital Infection Incident Assessment (HIIA) Tool' (also referred to as HIIAT). Available online: <http://www.documents.hps.scot.nhs.uk/hai/infection-control/toolkits/hiiat-2011-10.pdf>;
- 'Healthcare Outbreak Algorithm For Patient, Healthcare Worker and Visitor (PHV) Safety to optimise patient, healthcare worker and visitor safety during outbreak investigations'. Available online: <http://www.documents.hps.scot.nhs.uk/hai/infection-control/toolkits/hospital-outbreak-management-2013-05.pdf>.

The Scottish MRSA Reference Laboratory can be contacted for expert advice (contact details at <http://www.smrsarl.scot.nhs.uk/>).

8.1.1 Infection Prevention and Control (IPC) Measures in Relation to Patients with Necrotising Pneumonia

Standard Infection Control Precautions (SICPs) must continue to be applied. In addition: HCWs should wear facial and respiratory protective equipment e.g. a fluid repellent surgical face mask with integral eye protection if there is likely splashing or spraying of blood/body fluids from patient contact or procedure e.g. during intubation and any respiratory care of a patient with known/suspected necrotising pneumonia (refer to the National Infection Prevention and Control Manual: <http://www.hps.scot.nhs.uk/haiic/ic/nationalinfectionpreventionandcontrolmanual.aspx>).

If a HCW has direct contact with respiratory secretions from a PVL-positive patient they should be advised to seek advice from the local Occupational Health Service. If a HCW subsequently becomes unwell (fever, flu-like illness, sore throat) 3 to 7 days post exposure they should be advised to seek medical attention.

8.1.2 IPC Measures in Relation to Hospital-acquired Infections

If a case of PVL-*S. aureus* infection was acquired or there is the possibility it was acquired, in hospital, a risk assessment needs to be undertaken by the Infection Prevention & Control Team and infection prevention and control measures put in place (as above).

If there are linked cases suggesting an outbreak or cross infection, screening and decolonisation of other patients and staff (if the epidemiology suggests this) should be considered by the Incident Management Team (IMT).

The Microbiology department should search its database for *S. aureus* infections with an alert antibiogram that may be related, and any isolates, if still available, sent to the SMRSARL for PVL-testing. This will help to ascertain any unidentified clusters of cases in the hospital.

It is good practice that any significant learning points as a consequence of post-incident or outbreak review are shared locally and nationally.

8.1.3 Occupational Health

A HCW with a proven PVL-*S. aureus* infection should not work until the acute infection has been resolved and until at least 48 hours of a five day decolonisation regimen has been completed. A risk assessment will need to be undertaken with input from Infection Prevention and Control staff or Microbiologist depending on the nature of the work. Enquiries regarding PVL-*S. aureus*-related disease in close household/sexual contacts of the staff member should be made, so decolonisation and treatment can be offered simultaneously, if required.

Follow up samples, following topical decolonisation, are advised as for MRSA guidelines (three screens, one week apart). Unlike MRSA, staff who are found to have PVL-*S. aureus* are likely to have acquired the infection in the community, and hence re-colonisation may occur from a close contact. Therefore, even if screens have been negative, staff should stop working and seek both treatment and Occupational Health advice if a further skin lesion develops.

If, despite two courses of decolonisation treatment, a staff member remains colonised, they should be able to continue work providing they are not implicated in hospital transmission of PVL-*S. aureus* infection and they cease working as soon as an infected skin lesion develops. This will require individual assessment of risks to patients and the staff member and will require multidisciplinary input including Occupational Health, Infection Prevention and Control staff and the line manager.

Occupational health issues will be the responsibility of the patient's employer in conjunction with the GP treating the infection.

8.2 Infection Prevention and Control Measures for Household Settings

The key principles of preventing and controlling the spread of infection in the household setting centre on:

- early suspicion of infection, with rapid diagnosis and appropriate treatment;
- the natural course of the infection with relapses;
- environmental survival of the bacteria.

Measures that can be put in place to reduce spread within a household:

- ensuring lesions are covered with clean, dry dressings, which are changed and disposed of as soon as discharge seeps to the surface;
- personal hygiene and good skin care (particularly those with eczema);
- using separate towels and not sharing personal items such as razors, toothbrushes, face cloths etc.; replacement of personal utensils e.g. toothbrushes, combs;
- ensuring laundry of towels, bedlinen, clothing etc using a hot wash (60°C), where possible - daily;
- regular household cleaning - daily where possible;
- avoiding communal and recreational settings until lesions are healed if they cannot be adequately contained by a dressing; certain activities such as use of gym, sauna, swimming pool use, massages, manicures or similar, should be avoided until the lesions have healed.

Further advice:

- those who work in occupations where they might pose a risk of infection to others, such as healthcare workers; carers in nurseries, residential or care homes or similar; or food handlers, should not attend work until the lesions have healed;
- those who have eczema or a more generalised skin condition should remain off work or school until treatment has been completed;
- children can go to school if they can understand the importance of good hand hygiene, and can keep their infected skin covered with a clean dry dressing which will stay dry and in place until the end of the school day.
- children attending nurseries will require individual assessment in terms of suitability to return to nursery.

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Appendix A: Quick Reference Guide for PVL-*S. aureus* for Primary Care (Adapted from HPA Chart 18/5/09)

Quick Reference Guide for PVL-*S. aureus* for Primary Care

- Usually skin infections, but also severe invasive infection in otherwise healthy young individuals.
- Infections can be recurrent over several months, affect several household members and disrupt work, school and social life.

Characteristics of infection with PVL-*S. aureus*

Recurrent skin infections

- Boils, carbuncles, cellulitis.
- Pain and erythema out of proportion to severity of signs.
- Necrosis may be present.

Invasive infections

- Necrotising pneumonia after a flu-like illness.
- Necrotising fasciitis.
- Purpura fulminans.
- Osteomyelitis, septic arthritis, pyomyositis.

Risk factors and groups at high risk for PVL-*S. aureus*

- Closed communities with close contact e.g. care homes, healthcare premises, prisons etc.
- Contact sports (rugby, wrestling etc.).
- Military training camps.
- Gyms.
- Travel outwith UK.
- Contact with a known case.

Factors contributing to cross infection:

- Crowding.
- Close contact (household/sexual).
- Cuts/compromised skin integrity.
- Contamination of environment.

When should I investigate for PVL-*S. aureus*? NB: State PVL on request form

- Recurrent boils and abscesses.
- Necrotising skin and soft tissue infection.
- More than one typical case in household or closed community.
- Community acquired necrotising/haemorrhagic pneumonia (sputum, swabs, and refer to hospital immediately).

What bacteriology samples should I take? Make sure PVL I son request

- Swabs submitted in locally specified manner of skin lesions/breaks, pus etc.
- Others depending on nature of infection.

When and how do I treat PVL-infections?

- Abscesses should be incised and drained. Send pus for culture if PVL suspected.
- Cellulitis, large abscesses pending drainage give flucloxacillin orally 5-7 days.
- Clindamycin or cotrimoxazole can be used for penicillin allergic patients.

If MRSA is suspected or confirmed empiric MRSA treatment as per your local antibiotic protocols.

If there is severe SSTI with systemic symptoms or pneumonia refer to hospital immediately.

When should I offer decolonisation? (Limited evidence, expert consensus)

- To index cases after lesions have healed (no re-screening unless high risk group).
- To household contacts of necrotising/haemorrhagic pneumonia (no screening needed).
- If index case is a special risk to others (healthcare worker) with re-screening.
- Give patient local information leaflet on decolonisation protocol.
- Only after infection is resolved.

Follow up

- Should not attend work/school or nursery whilst lesion is active or cannot be covered.
- Healthcare staff should contact their Occupational Health Department for assessment.
- Patient information leaflet should be provided for those with confirmed PVL.

Appendix B: Patient information – Decolonisation General Information

Decolonisation procedure for PVL-*Staphylococcus aureus* (PVL-*S. aureus*)

The purpose of decolonisation is to try to reduce the number of bacteria in carriage sites; moist areas of the body, such as nose, armpits and groin, to reduce relapses of infection, spread to close contacts or risk of a wound infection before an operation for example. Generally you will be advised to have any infection treated and settled before decolonisation starts. Sometimes if a close contact has a **very** serious infection you may be advised to have the decolonisation earlier.

The decolonisation consists of two parts (1) an antiseptic skin wash instead of normal soap and (2) an antiseptic nose cream for 5 days. You will be given details on how to use this.

This will not get rid of the bacteria if they are in other carriage sites such as the gut or throat and it may not be completely successful in all cases. However, most people with PVL-*S. aureus* carry it in the nose and sometimes reducing the number of the germs can help to break an ongoing cycle of infection between close contacts.

It is not of proven value in PVL management, but similar approaches have been used for many years to reduce MRSA colonisation and generally it is safe and well tolerated.

This treatment will only be started once any infection is treated for the best chance of success.

Reducing spread of the bacteria within the households during the antiseptic treatment:

- Clean your hands often (before touching young children, preparing food, eating, doing housework and after going to the toilet). Keep fingernails short.
- If possible change underwear, bedding, clothing and towels daily. If you can't manage this try at least to do it on days 2 and the last day the treatment.
- Use fresh wash cloth daily or use a disposable one and throw it away every day; or avoid using them at all. Don't share toothbrushes, hair brushes, towels, washcloths etc.
- Pay particular attention to armpits, groin, 'down below' when using the antiseptic soap. If possible use the antiseptic soap in your hairline/hair (avoid if hair is coloured or permed).
- If your skin gets itchy with the antiseptic body wash stop using it and contact your GP.
- If your household contacts are also to be given the antiseptic treatment it's useful if you all start it together.

Appendix C: Patient Information PVL-*Staphylococcus aureus*

What is PVL-*Staphylococcus aureus* (PVL-*S. aureus*)?

Staphylococcus aureus is a germ that commonly lives on healthy skin. About one third of healthy people carry it quite harmlessly, usually on carriage sites; moist areas of the body, such as nose, armpits and groin, this is known as colonisation. A small number of *S. aureus* can produce a toxin called Panton-Valentine Leucocidin (PVL) and they are known as PVL-*S. aureus*.

Less than 2% of *S. aureus* produce this toxin and it can be found in MRSA or methicillin sensitive *Staphylococcus aureus* (MSSA). PVLs are mainly found in the community rather than in hospitals. Both MSSA and MRSA types are sensitive to a variety of antibiotics – many of which are available as tablets.

What type of illness does it cause?

PVL strains may cause no infection (carriers) or they may cause infections like boils or abscesses – these may well occur several times. Very rarely they can cause more serious infection of the lungs or bones which may require hospital treatment.

How do you catch PVL-*S. aureus*?

Anyone can get a PVL-*S. aureus* infection. Infection can also occur in fit, healthy people during skin-to-skin contact with someone who has the germ, for example within a family, during contact sports like rugby, or from contaminated surfaces for example shared gym equipment, razors, towels etc. Damaged skin can be more prone to infection with any *S. aureus*, including PVL.

How is PVL-*S. aureus* treated?

Boils and abscesses should be drained of pus where possible. Some infections (MSSA or MRSA) may be treated with a course of antibiotic tablets and there are several different choices available.

In certain cases the doctor may suggest the use of antiseptic washes and nose ointments to reduce the number of germs present on the skin after infection has healed. This may help reduce the chance of repeated infection or break a cycle of infection occurring in different household members. It may not get rid of the germ completely. In cases where there are other household or close contacts suffering infections, the antiseptic wash and nose ointment may be suggested for everyone.

How do I prevent passing PVL-*S. aureus* to other people?

Keep the infected areas covered with clean, dry dressings or plasters. Change these regularly or as soon as you see seepage to the surface of the dressing/plaster. Wash your hands before and after changing the dressings.

Do not touch, poke or squeeze infected skin. This transfers the germs to your hands and can push them deeper into the skin.

Cover your nose and mouth with a tissue when you cough or sneeze, particularly if you have a cold, because the germs can live in your nose. Throw the tissue in the bin at once and then wash your hands.

Try and keep personal items like towels, razors, toothbrushes, etc for your own use. Wash towels frequently at the highest temperature the materials will allow.

Can I go to work or school when I have a PVL-*S. aureus* infection?

- You should not work as a carer in a nursery, hospital, residential or care home or similar place until your skin has healed and you have permission to return to work from your local Occupational Health Department, GP or manager.
- You should not work in the food industry, e.g. waitress, chef, food production, until your skin has healed and you have permission to return to work from your local Occupational Health Department, GP or manager.
- You may carry on with other types of work, provided you keep infected skin areas covered with clean, dry dressings. If you are not sure about working, contact your local Occupational Health Department or GP.
- Children can go to school if they are old enough to understand the importance of good hand hygiene, and if their infected skin is covered with a clean dry dressing which will stay dry and in place until the end of the school day. Children should not take part in contact sports, or use communal gym equipment until their skin is healed. The GP's advice is essential and school management should be informed.
- People with eczema or a more generalised skin condition should take advice from their GP whether to remain off work or school. You need to continue treating your skin to keep it in good condition. In the long term this helps to reduce the risk of spread of PVL-*S. aureus*.

Can I go to swimming pools, gyms or sports facilities when I have a PVL-*S. aureus* infection?

You should not use communal facilities for example gym equipment, saunas, swimming pools, or have a massage, manicure or similar until your skin has healed.

How do I prevent becoming infected again?

If you are found to carry PVL-*S. aureus* persistently on your skin or nose, or if you suffer from repeated infections, you may be given a course of skin and nose disinfectant treatment. Sometimes the skin treatment will be extended to your household or close contacts. In these circumstances it is important that all affected people in a household or social group are treated at the same time.

If you have a further infection of any type, if you are admitted to hospital unexpectedly, or if you are going to be admitted to hospital for an operation, always tell the doctor or nurse looking after you that you have had a PVL-*S. aureus* infection. This will ensure that you receive appropriate treatment.

Appendix D: Guideline Development Group (GDG) Membership

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Appendix E: HPN Guideline Feedback form



HPN Guideline Feedback Form

Section A – About the Document (Guideline)

Guideline Title:

Author:

Publisher:

Date of Publication:

Section B – About the Evaluation

Reviewer's Name:

Reviewer's Occupation:

Reviewer's Organisation:

Reviewer's Contact Email Address: *(Optional)*

Date of Evaluation:

Section C – Comments

1. Does the Guideline meet your needs/inquiry at the time of evaluation?
(Please explain why this is the case.)

2. Is there anything lacking in the Guideline? (Please explain.)

3. Do you have any other comments?

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