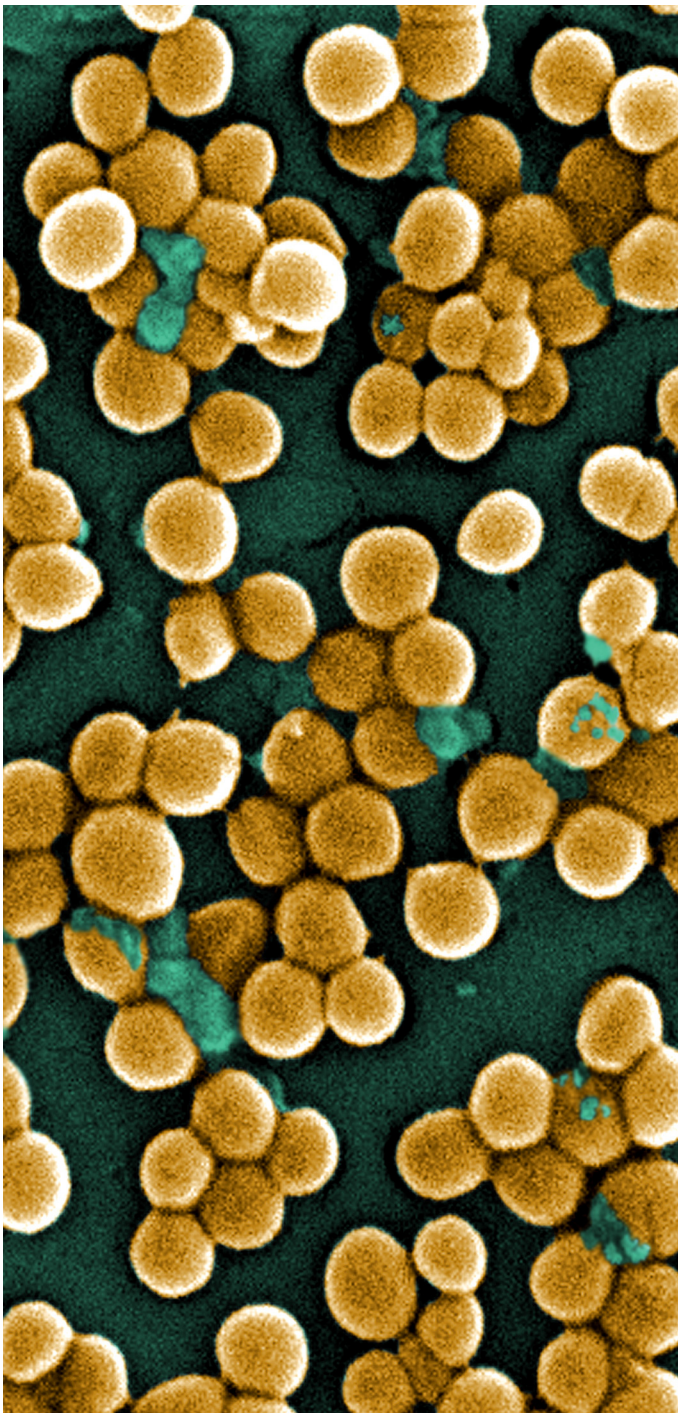


Guidance on the diagnosis and management of PVL-associated *Staphylococcus aureus* infections (PVL-SA) in England

Report prepared by the PVL sub-group of the Steering Group on Healthcare Associated Infection



Guidance on the diagnosis and management of PVL-associated *Staphylococcus aureus* infections (PVL-SA) in England, 2nd Edition.

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**Guidance on the diagnosis and management
of PVL-associated *Staphylococcus aureus*
infections (PVL-SA) in England**

This guidance was prepared by a sub-group of the Steering Group on Healthcare Associated Infections (SG-HCAI) at the request of the Department of Health and replaces that drafted by Health Protection Agency (HPA) working group in 2006. It is based on expert opinion following review of the literature and experiences of colleagues in the UK, Europe, the USA and Canada. There is little hard research evidence to support this guidance, particularly with reference to screening and decolonization. Existing international guidance and expert opinion range from a highly proactive 'search and destroy' approach to a more pragmatic, reactive approach. This guidance tries to steer a course between these, based on risk assessment of the situation and will be updated as developments in the field occur.

This guidance is intended to provide healthcare professionals with easily accessible advice on the recognition, investigation and management of PVL-*Staphylococcus aureus* (PVL-SA) cases. Guidance on the diagnosis and management of methicillin-resistant *Staphylococcus aureus* (MRSA) infections presenting in the community¹ has been produced by the British Society for Antimicrobial Chemotherapy (BSAC) to supplement existing MRSA guidelines at the request of the Specialist Advisory Committee on Antimicrobial Resistance (SACAR) and there has been close collaboration and joint membership between the sub-groups to ensure that guidance in areas of overlap is consistent.

1. Background

Panton-Valentine Leukocidin (PVL) is a toxin that destroys white blood cells and is a virulence factor in some strains of *Staphylococcus aureus*. Strains of PVL-SA producing a new pattern of disease have emerged in the UK and worldwide. In the UK the genes encoding for PVL are carried by < 2% of clinical isolates of *S. aureus* submitted to the national Reference Laboratory, whether methicillin-sensitive (MSSA) or methicillin-resistant (MRSA).²

While PVL is currently accepted as an important virulence factor in *S. aureus*, some recent publications call this into question. Alternatives such as the Arginine Catabolism Mobile Element (ACME), α -toxin, regulation of gene expression, and/or newly described cytolytic peptides have been put forward to explain the pathogenicity associated with PVL-SA. These bacterial aspects, in conjunction with host factors, are the subject of intense investigation and are key to furthering our understanding of the virulence of PVL-SA. Nevertheless, PVL has been strongly associated epidemiologically with virulent, transmissible strains of *S. aureus*, including community-associated (CA) MRSA. In summary, PVL remains a valuable marker and target for screening for virulence in some strains of *S. aureus*.

Strains of *S. aureus* encoding the PVL genes were recognised in the early 1900s in staphylococcal skin abscesses. In the 1950s and '60s, the 'phage type 80/81 strain spread widely. This strain was PVL-positive (PVL-MSSA) and proved highly successful in the UK and abroad, causing widespread disease (most commonly boils and abscesses) in previously healthy individuals in the community, as well as in hospitalised patients and healthcare workers.

The escalation in morbidity and mortality associated with PVL-MRSA has caused public health concern worldwide. To date most PVL-SA strains in the UK have been MSSA, but a major problem has emerged with CA-MRSA in North America, most of which produce PVL. One strain in particular, the USA300 clone, is now spreading in hospitals in the USA.³

From a UK perspective, occasional fatalities due to PVL-SA and outbreaks 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. Following national alerts and improved case ascertainment initiatives, the HPA has been monitoring PVL-related disease throughout England and Wales.

During 2005 and 2006, a total of 720 cases of PVL-SA were identified from isolates referred to the Reference Laboratory for testing and characterization. Of these, 224 were in 2005 and 496 in 2006, representing a two-fold increase. However, initiatives have been underway in this period to raise awareness of PVL-SA, so it is unclear how much of this increase is due to improved ascertainment. The majority of referred isolates were PVL-MSSA (444, 62%). Most PVL-SA were from sporadic cases presenting with relatively mild skin and soft tissue infections. Occasional clusters of disease centred around close household contacts; two outbreaks in healthcare settings have been documented.

On the basis of these data, infections caused by PVL-SA are currently uncommon in England and Wales and it is not clear whether the increasing numbers observed between 2005 and 2006 reflect improved case ascertainment of PVL-related syndromes and/or an increasing prevalence of PVL-SA. Planned systematic surveillance-based studies will provide more robust data for monitoring trends.

1.1 Clinical features of PVL-SA

Like other *S. aureus* strains, PVL-SA predominantly cause skin and soft tissue infections (SSTI), but can also cause invasive infections. The most serious of these is a necrotising haemorrhagic pneumonia with a high mortality, which often follows a "flu-like" illness, and may affect otherwise healthy young people in the community.

1.2 Skin and soft tissue infections

These are often recurrent and include:

- Boils (furunculosis), carbuncles, folliculitis, cellulitis, purulent eyelid infection
- Cutaneous lesions $\geq 5\text{cm}$ in diameter, which need different treatment from smaller lesions
- Pain and erythema out of proportion to severity of cutaneous findings
- Necrosis

1.3 Invasive infections

- Necrotising pneumonia
- Necrotising fasciitis
- Osteomyelitis, septic arthritis, and pyomyositis
- Purpura fulminans

Patients who develop necrotising pneumonia commonly have a preceding "flu-like" illness. The percentage of genuine virus infections is unknown, but co-infection with respiratory viruses, including influenza, should be investigated.

1.4 Risk factors for PVL-SA

The risk factors for PVL-SA seen in the UK correspond to those described for CA-MRSA in North America. These include compromised skin integrity, skin to skin contact, and sharing of contaminated items such as towels. Worldwide experience suggests that closed communities with people in close contact are higher risk settings for transmission of staphylococcal infections.

In North America the following settings have been identified as higher risk for transmission from an individual colonised or infected with CA-MRSA:

- households
- close contact sports e.g.: wrestling, American football, rugby, judo
- military training camps
- gyms
- prisons

CDC guidance refers to risk factors for PVL-related infection as "5 C's": 1) **C**ontaminated items; 2) **C**lose contact; 3) **C**rowding; 4) **C**leanliness; 5) **C**uts and other compromised skin integrity.⁴

CA-MRSA has become endemic in some hospitals in North America and caused several outbreaks. Features which differentiate typical healthcare-associated (HA)-MRSA (e.g. EMRSA-15 and -16 in the UK) from CA-MRSA in these circumstances are well documented and summarised in Table 1.

Table 1. Hospital-associated MRSA versus Community-associated-MRSA*

Hospital-associated MRSA	Community-associated MRSA**
<u>Typical patients</u>	
Elderly, debilitated and/or critically ill or chronically ill	Young healthy people, students, athletes, military service personnel
<u>Infection site</u>	
Wounds/invasive devices Often cause bacteraemia	Often spontaneous Skin, cellulitis, abscess
<u>Transmission</u>	
Within healthcare settings; little spread among household contacts	Community-acquired; may spread in close community settings, e.g. families sports teams, via pets (not so far in UK).
<u>Diagnosis is typically made</u>	
In an in-patient setting	In an out-patient setting
<u>Medical history</u>	
History of MRSA colonization/infection, recent surgery, admission to hospital or nursing home, antibiotics, renal dialysis, permanent indwelling catheter, skin ulcers, diabetes	No significant medical history
<u>Virulence factors</u>	
Community spread limited. PVL genes absent	Community spread readily, PVL genes present, predisposition to necrotising skin and soft tissue infection
<u>Antibiotic susceptibility</u>	
Choice of agents limited	Currently more susceptible to antibiotics*

* From the North American literature; many points resonate with experience thus far in the UK.

** This is an evolving situation and CA-MRSA infections have been acquired in some countries, albeit rarely in the UK, hence the need for vigilance. More resistant CA-MRSA are emerging in some parts of world and distinguishing these from HA-MRSA based on susceptibility profiles can be problematic

1.5 When to suspect PVL-SA infection

PVL-associated SA infection should be suspected if a patient has a necrotising SSTI, recurrent furunculosis or abscesses, or there is clustering of SSTIs within a household or social group; also in invasive infections in immunocompetent people, particularly community-acquired necrotising/haemorrhagic pneumonia in young, previously fit people. Haemophthisis should be a major alerting sign. PVL infections are associated with enhanced inflammatory response (higher ESR and C-reactive protein [CRP]), local disease (myositis/pyomyositis), acute haematogenous osteomyelitis or osteoarticular infections in children.⁵

2. Microbiological Sampling

Figure 1 shows an algorithm for the appropriate testing of specimens in suspected PVL-SA related disease. PVL genes can be carried by both MSSA and MRSA. PVL-MSSAs display variable antimicrobial susceptibility profiles, which can be geographically distinct. Whilst most PVL-MRSAs in the UK are susceptible to ciprofloxacin, resistance has occasionally been found, for example in PVL-MRSA isolated from patients returning from USA.

2.1 Microbiological testing of clinical samples

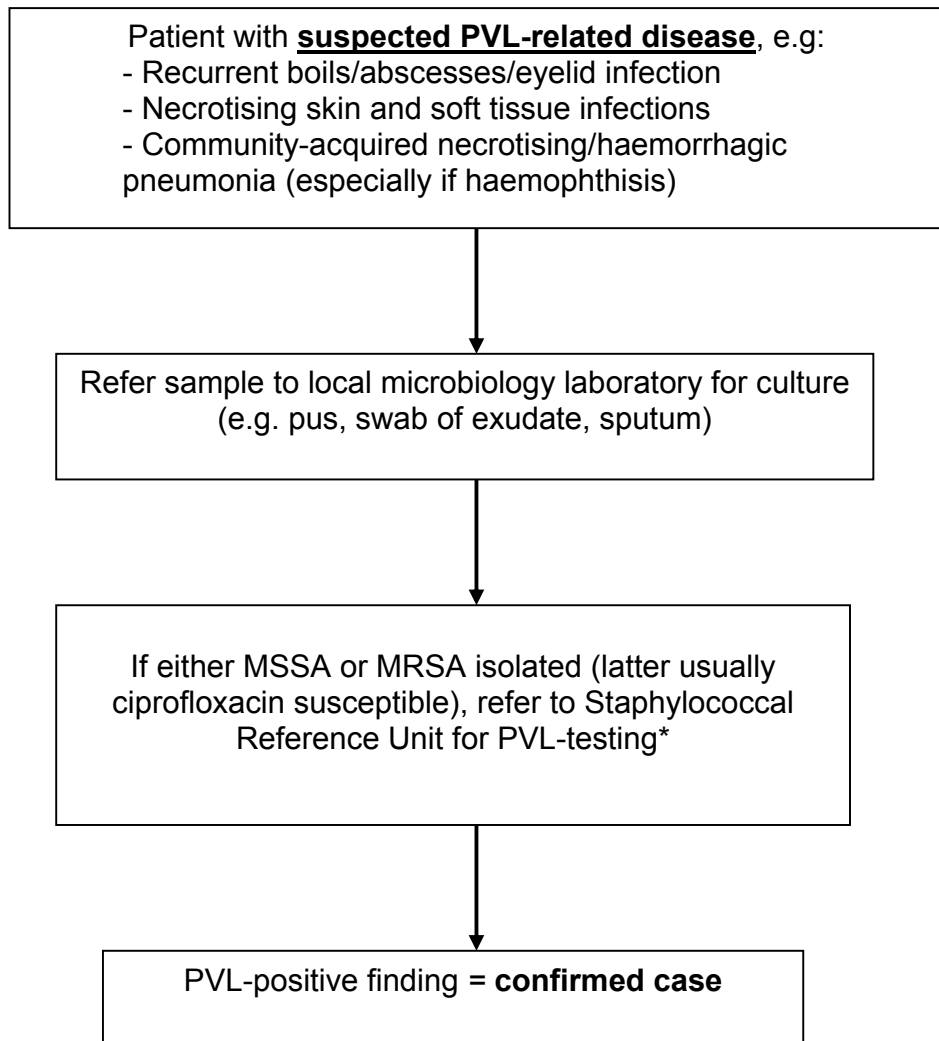
Appropriate clinical samples (e.g. pus, swab of exudate from an abscess or other lesion, sputum) from suspected cases should be sent to the local microbiology department. In case of queries, the local microbiology department should be asked for advice. Accident and Emergency (A&E) departments and GPs must be alerted to the importance of taking specimens when incising and draining abscesses. Samples should be cultured on non-selective media (e.g. blood agar) for the recovery of potential pathogens, including *S. aureus*. If necrotising pneumonia is suspected, co-infection with a respiratory virus, including influenza, should be investigated.

2.2 PVL testing

MSSA or MRSA isolated from suspected cases should be referred to the Staphylococcus Reference Unit at the HPA's Centre for Infections at Colindale for toxin gene profiling, which includes PVL testing (Figure 1). This PCR-based assay is performed daily and completed within a working day. If cases are urgent, results will be telephoned to the submitting laboratory. Even if PVL testing is performed locally, isolates must be sent to the Reference Unit 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 HA-MRSA and likely to have been acquired in a healthcare setting should not be referred unless the history suggests a PVL-SA infection, e.g. necrotising pneumonia, recurrent boils. This information must be included on the referral forms. Ciprofloxacin-resistant MRSA should not be referred to the Staphylococcus Reference Unit for PVL testing unless they are associated with typical PVL-SA-related disease.

Figure 1. PVL-related disease: Microbiology algorithm ⁶



*For urgent requests, please contact Staphylococcal Reference Unit (Tel: 020 8327 7227).

2.3 Microbiological testing of screening samples

Where a confirmed case is due to PVL-MSSA, screening swabs should be cultured on non-selective media (e.g. blood agar). Where *S. aureus* with an antibiogram which matches that of the confirmed case is recovered, isolate(s) should be referred to the Staphylococcus Reference Unit.

Where the confirmed case is due to PVL-MRSA, screening swabs should be cultured on selective media, such as Mannitol Salt Agar or chromogenic media. As most PVL-MRSA are currently susceptible to ciprofloxacin, selective media which contain ciprofloxacin must be avoided. Where MRSA is recovered with an antibiogram which matches that of the confirmed case, isolate(s) should be referred to the Staphylococcus Reference Unit.

2.4 Suspected outbreaks

To investigate outbreaks in community or healthcare settings, inter-strain comparisons (e.g. DNA fingerprinting) should be performed to determine strain relatedness. This can be performed by the Staphylococcus Reference Unit.

Criteria for referring isolates to the unit are on the HPA website at:

http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1204619484795

2.5 Antimicrobial susceptibility testing

This should be performed in the routine way for the laboratory and should include testing for dissociated resistance (D-test) to clindamycin.¹

3. Management of cases

3.1 Skin and soft tissue infections

Minor SSTIs (furunculosis, folliculitis, small abscesses/boils without cellulitis) do not need systemic antibiotic treatment unless the patient is immunocompromised, an infant or deteriorating clinically. Incision and drainage is the optimal management for abscesses.

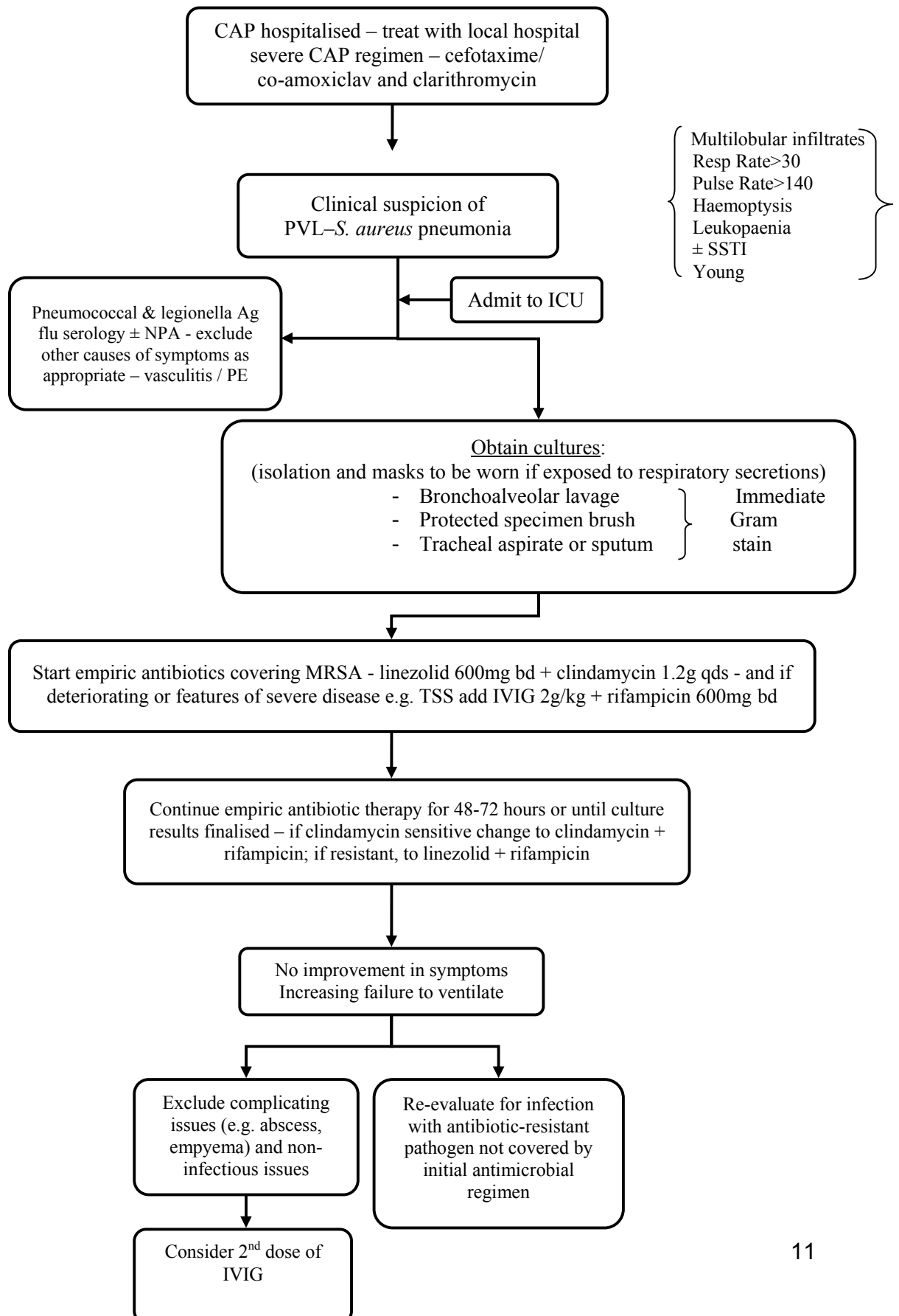
Moderate SSTIs including cellulitis and larger abscesses (especially those > 5cm) should be treated with oral anti-staphylococcal antibiotics in addition to drainage - see 3.1.2.

If there is systemic involvement suggestive of toxic shock or pyomyositis (hypotension, tachycardia, diarrhoea, vomiting, high creatine kinase) use empirical parenteral antibiotics effective against MRSA together with immunoglobulin (IVIG) — see Figure 2.

3.1.1 General care

Lesions should be covered, personal hygiene emphasised (avoid sharing towels, bath water etc.), and patients advised to return if the lesions do not resolve or there is clinical deterioration. See Appendix 1 for a patient information leaflet.

Figure 2. Management of patient with suspected PVL-related pneumonia



3.1.2 When antimicrobials are indicated for skin and soft tissue infection

Most PVL-SA in the UK are susceptible to flucloxacillin, erythromycin and clindamycin, although tests need to be performed for dissociated resistance to clindamycin in erythromycin-resistant strains (see 2.5). Adult doses are given – for paediatric doses see BNFC.

For moderate SSTI with MSSA use either:

- flucloxacillin 500mg qds
or
- clindamycin 450 mg qds

When PVL-MRSA is suspected and hospital admission is not warranted use:

- rifampicin 300mg bd PLUS doxycycline (100mg bd – not for children <12 y)
or
- rifampicin 300mg bd PLUS fusidic acid 500mg tds
or
- rifampicin 300 mg bd PLUS trimethoprim 200 mg bd
or
- clindamycin 450 mg qds

Treatment should last 5-7 days. Some PVL-MRSA strains are resistant to doxycycline and fusidic acid (A Kearns, Staphylococcal Reference Unit, unpublished data), so treatment must be guided by antimicrobial susceptibility tests. Care should also be taken with rifampicin and fusidic acid in combination as resistance to both agents may be selected. There should also be vigilance for hepatotoxicity.

For severe infections where PVL-SA (MSSA or MRSA) is suspected parenteral vancomycin, teicoplanin, daptomycin or linezolid have been used. Tigecycline may also offer broader polymicrobial cover. There is no evidence that any one agent is superior. In severe infections with features of toxic shock, necrotising fasciitis, or purpura fulminans there may be a theoretical case for using two or three agents such as linezolid 600mg bd combined with clindamycin 1.2 - 1.8g qds and rifampicin 600mg bd. This case is based on in-vitro synergy and the ability of linezolid and clindamycin to switch off toxin production.⁷ It is very important to undertake early surgical debridement. Treatment should be continued for 10-14 days until the patient has improved and is clinically stable.

3.2 Community-acquired necrotising pneumonia

Figure 2 shows an algorithm for the management of patients with suspected PVL-SA pneumonia. Early clinical diagnosis is difficult but essential for survival, especially as only 25% of cases may have current, or a history of, skin lesions (however, there may be a family history of spreading or recurrent PVL-SA skin sepsis⁸). Respiratory symptoms and sepsis in a previously fit young patient following a "flu-like" illness warrant prompt referral to hospital. Once admitted, the

following classical constellation of findings⁹ strongly suggests the diagnosis, although in early cases only some may be present.

Clinical signs

- airway bleeding/haemoptysis
- hypotension
- non-specific findings of “flu-like” illness e.g. myalgia, chills, fever of 39°C or above, tachycardia >140 beats/min, diarrhoea and vomiting (may be due to associated toxic shock)

Radiography

- multilobular infiltrates on chest X-ray, usually accompanied by effusions and later cavitation.

Laboratory investigations

- Gram film of sputum reveals numerous gram-positive cocci in grape-like clusters
- marked leukopenia (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
- significantly raised serum creatine kinase (suggests myositis)
- the CURB65 score¹⁰ may be misleadingly low in young adults as age is a score factor

3.2.1 Clinical management of necrotising pneumonia (mainly supportive)

- Admit to Intensive Care — preferably a side room with isolation (wear appropriate PPE)
- Aggressive antimicrobial therapy — see 3.2.2
- Give intravenous immunoglobulin (IVIg) in a dosage of 2g/kg — see below

Activated Protein C should *not* be used in case there is active pulmonary haemorrhage, and is contra-indicated in children. It may be indicated for adults with severe sepsis due to other causes, who do not have haemorrhagic pneumonia.¹¹

3.2.2 Antimicrobial therapy of necrotising pneumonia

The efficacy of many antibiotics in treating necrotising pneumonia is decreased by reduced penetration into necrotic tissue and diminished activity in anaerobic conditions. There are many differing opinions on therapy for PVL-associated pneumonia. Unfortunately few reports include doses, and some involve antibiotics not routinely available in the UK. Work is ongoing to establish optimal therapy. The following points from the published literature are intended as background information.

Intravenous flucloxacillin is not recommended, even in combinations with agents such as rifampicin or clindamycin. Although bactericidal, there are concerns that at concentrations just above the MIC (likely with poor penetration into necrotic tissue) flucloxacillin may *increase* PVL production as it does *in vitro*.¹²

Where an agent that inhibits toxin production was included, the outcome has been generally more favourable, but with so few cases and so many regimens, there is no proof that any one is unequivocally superior. Combinations of clindamycin with rifampicin,¹³ linezolid with rifampicin,^{14,15} vancomycin with rifampicin,¹⁶ and vancomycin with clindamycin have all been successful, but with widely differing durations of intravenous therapy, sometimes as long as four weeks.¹⁶ Rifampicin should never be used alone as resistance is rapidly selected.

Co-trimoxazole is not recommended for pneumonia. The only report of successful therapy described highly unusual chronic (3-months) pneumonia and involved three days of intravenous vancomycin followed by six weeks of co-trimoxazole.¹⁷ Although three cases of success with vancomycin as sole initial therapy have been reported,¹⁸⁻²⁰ vancomycin should not be used alone because of poor extracellular fluid levels²¹ and poor penetration of lung tissue.²²

Clinical failures with continuing bacteraemia and persistence in bronchial secretions have necessitated repeated courses of vancomycin,²³ or changing to linezolid and rifampicin.^{14,15} A loading vancomycin dose of 25mg/kg has been suggested, and thereafter dosage adjusted to give trough serum levels of 15-20 mg/dl to achieve a plasma concentration of 3-4 mg/dl.²⁴ Even with a dose of 1.5g bd and trough levels of 18-35 mg/dl, fluid from bronchiolar lavage was not sterilised after seven days.¹⁴

There are reports of success following "salvage" therapy using linezolid alone or with rifampicin to replace failing vancomycin therapy.^{14,15,25,26}

Rifampicin has been used in different antibiotic combinations. It has excellent tissue penetration, reaching intracellular staphylococci, and exhibits synergistic activity with other antibiotics, including linezolid.²⁷

Taking all the information above into consideration, the sub-group recommends empirical therapy with a combination of clindamycin 1.2 g iv qds, linezolid 600 mg iv bd (to suppress PVL and alpha toxin production^{12,28,29}) and rifampicin 600 mg bd (for intracellular clearance of staphylococci). Providing the infecting organism is susceptible on testing, this combination should be continued until the patient has improved and is clinically stable, when continuation therapy with linezolid plus rifampicin, or with clindamycin plus rifampicin, may be considered for 10-14 days, guided by the clinical response and infection markers such as CRP.

3.2.3 Adjunctive therapy with Intravenous Immunoglobulin (IVIG) in necrotising pneumonia

IVIG should be considered in addition to intensive care support and high dose antimicrobial therapy because of its action in neutralizing exotoxins and superantigens, particularly enterotoxins A, B and C and TSST-1. The expected benefits outweigh the risks in a condition with such a high mortality (>60%). The dosage of 2g/kg of IVIG recommended for streptococcal toxic shock syndrome^{30,31} may be applicable for PVL- SA infections, and may be repeated after 48 h if there is still evidence of sepsis, or failure to respond. For children a dose of 1g/kg may be preferable to reduce the risk of hyperviscosity, and this may be repeated after 48 hours.

3.3 Osteomyelitis and other deep-seated infections

3.3.1 Investigations

- blood culture
- microscopy/culture of bone/joint specimens and any skin lesions
- serial MRI scan to determine extent of disease and response to therapy
- radio-isotope scan for metastatic infection
- assessment for deep vein thrombosis
- additional imaging for metastatic infection if not responding to treatment

3.3.2 Therapy of osteomyelitis and other deep-seated infections

PVL-MSSA infections: if the infection is known to be caused by PVL-MSSA, treatment should be guided by antimicrobial susceptibilities, using agents with good penetration into the relevant body compartment and which inhibit toxin production, such as clindamycin in combination with rifampicin or linezolid (see 3.2.2 for dosage).

If PVL-SA infection is suspected and antimicrobial susceptibilities are not yet known, treat as for PVL-MRSA (below).

PVL-MRSA infections: the BSAC guidelines¹ suggest that for MRSA osteomyelitis and other deep-seated infections the following protocol is used:

First-line:

Either teicoplanin (400–800 mg iv) every 24 h (following loading dose) or vancomycin (1 g iv 12 hourly)

PLUS either
gentamicin (5–7 g/kg iv once daily)
or
rifampicin (300 mg po twice daily)
or
sodium fusidate (500 mg po thrice daily).

Second-line:

linezolid (600 mg iv/po 12 hourly)
or
off label usage of daptomycin based on clinical judgement (6mg/kg or 8mg/kg iv once daily. This dosage is based on those used for other deep seated infections)
or
tigecycline (100 mg loading dose followed by 50 mg iv twice daily).

Notes:

- (a) Assessment in hospital likely to be required, with orthopaedic advice.
- (b) Bone and joint infections may require prolonged treatment and repeated surgery.
- (c) Serum vancomycin/teicoplanin and gentamicin concentrations should be monitored (trough concentrations for teicoplanin of 10–20 mg/L and for vancomycin of 10–15 mg/L).

3.4 Special consideration of infections in children

The approach is tabulated in Appendix 7.

3.4.1 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. The management is as for adults (see 3.1). The need for isolation should be discussed with the Infection Control Team.

3.4.2 Deep-seated infections in children

3.4.2.1 Clinical pointers

Abscesses: 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: 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.

Severe sepsis: 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.

Pneumonia: suspect if there is preceding “flu-like” illness, haemoptysis, multi-lobular infiltrates, bone or joint infection, leukopenia/neutropenia or patient or close family contact has current, or a history of, recurrent boils/abscesses or skin infections.

3.4.2.2 Investigation of deep-seated infections in children

General: cultures of blood, skin lesions, bone and joint specimens, sputum, bronchial secretions or lavage, as relevant. Assess for deep vein thrombosis adjacent to any site of infection.

Bone and Joint: see 3.3.1

Severe sepsis: imaging for occult foci of infection – especially bone/joint

Pneumonia: investigate using rapid tests for fast diagnosis of co-infection with influenza and other viruses.

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

General:

- resuscitate and stabilize using APLS guidelines
- consider thromboembolism prophylaxis and manage deep vein thromboses in consultation with a paediatric haematologist
- discuss need for isolation with Infection Control Team
- administer antibiotics according to local guidelines for empirical management of infections, but add clindamycin if PVL-MSSA is suspected and linezolid if PVL- MRSA is suspected or there is a suspicious travel history or failure to respond to treatment
- close monitoring of clinical condition is essential as some patients will deteriorate even after several days receiving appropriate antibiotic therapy

Bone and joint infections:

- aggressive approach to drainage of foci of infection

Severe sepsis/pneumonia:

- consider transfer to paediatric ICU
- give 1-2g/kg IVIG and repeat lower dose after 24-48 hours if needed (see below).

3.4.2.4 Further therapy of deep-seated infections in children

Once infection with PVL-SA is confirmed, use intravenous clindamycin (if susceptible) plus rifampicin, and consider addition of linezolid. Addition of linezolid may be particularly useful in bone and joint infections. Linezolid should be used for a maximum of 4-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).

As continuation therapy for bone/joint infections use clindamycin plus rifampicin, 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. Maintain vigilance for the occurrence of thromboses.

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.

Ensure appropriate consultation, for instance with medical microbiologist, paediatric infectious disease physician, orthopaedic surgeon or hematologist, as required.

4. Decolonization and screening of patients and their close contacts

4.1 Principles of decolonization

Topical decolonization is often used to try and interrupt transmission. Little data exist on its effectiveness for eradicating a particular strain of *S. aureus* and thereby preventing further infections, especially in non-healthcare settings and with prolonged follow-up. It can be achieved temporarily, but re-colonization can occur relatively quickly. So, whilst awaiting definitive trials, an empirical approach to screening and topical decolonization should be adopted. It should only be attempted after reinforcing standard prevention measures.

Factors that may reduce long-term success of topical decolonization include:

- non-compliance with the topical decolonization regimen
- attempts to decolonise whilst still shedding *S. aureus* from an infected lesion, e.g. healing abscess or break in the skin (chronic ulcer)
- re-colonization from a close contact
- re-colonization from the patient's own flora, e.g. gut, throat, vagina
- re-colonization from the environment.

For these reasons, the merits of undertaking a topical decolonization regimen should be critically assessed

- i. in a setting where non-compliance with the regimen is likely to be an issue
- ii. where there are breaks in the skin, e.g. varicose ulcers, from which *S. aureus* may continue to be shed.

Decolonization of neonates, especially premature neonates, is difficult and unstandardised. Where decolonization is required, nasal mupirocin may be used. Antiseptic solutions, such as chlorhexidine, may damage the fragile skin of premature neonates. In these circumstances, washing with plain water, even if just “topping and tailing”, may be helpful. When it is felt appropriate to use an antiseptic, this must always be an aqueous preparation and never alcohol-based (risk of burn injuries in neonates).

4.2 Decolonization of infected patients

Topical decolonization without prior screening should be offered to primary cases.

Patients should be given a patient information leaflets describing how to minimise cross-infection and when and how to use the topical agents (Appendix 1; Appendix 2). The topical decolonization regimen should be limited to five days. Topical decolonization should be started after the acute infection has resolved. In patients with dermatological conditions it is important to seek a dermatological opinion. Chlorhexidine is inappropriate for premature infants as it may damage their fragile skin and there may be systemic absorption as the skin’s barrier function is less effective.

Patients in whom recurrent infections or persistent colonization occur, despite reasonable efforts to decolonise or because of their underlying conditions, should maintain sensible precautions to prevent transmission in households and community settings, and this advice should be included in the patient information leaflet (example in Appendix 1).

Repeated screening is not recommended unless the patient is particularly vulnerable to infection, poses a special risk to others (e.g. a healthcare worker) or spread of infection is continuing in close contacts.

4.3 Screening and decolonization of contacts

Risk assessment should be undertaken to identify whether screening and/or decolonization are appropriate or feasible. The first step is an appraisal of the close contacts (household, family, partner) seeking information on current or previous possible PVL-SA infections in the previous year, such as septic skin lesions. In addition, it is important to enquire about employment history and contact with healthcare settings. Where close contacts are infected or likely to be colonised because of a history of past infection, they should undergo decolonization at the same time as the patient, without prior screening.

If screening is undertaken, it must include a swab of the anterior nares, throat and any suspicious lesions, including damaged skin. Other sites that may be swabbed include perineum and axilla. Until new research becomes available it may be simpler to use local MRSA screening protocols. If any household contacts are found to be positive on screening, it is recommended that decolonization is offered to the whole household at the same time.

Patients and their families should have a heightened awareness of any continuing problems of PVL-SA-related disease in the family or close contacts and return to their GP for consultation should this happen.

Repeated screening is not recommended unless the contacts are particularly vulnerable to infection, pose a special risk to others (eg a healthcare worker) or spread of infection is continuing. In these circumstances repeat screening should not be undertaken until at least one week post-decolonization, and a second round of topical decolonization prescribed if still positive. The focus should be on emphasizing good hygiene and infection control procedures as described in Appendix 1. The advice of a dermatologist should be sought where there are pre-existing dermatological conditions.

4.3.1 Decolonization of family contacts of a case of necrotising pneumonia

Close (e.g. partner) or household contacts of a patient diagnosed with necrotising pneumonia likely to be caused by PVL-SA may be the source of, or acquire and subsequently suffer, infections with PVL-SA.³² Close contacts should be offered a five-day topical decolonization regimen starting immediately (including chlorhexidine gargle if feasible). Consideration should be given to using oseltamivir prophylaxis if the index case is found to have had influenza and advice obtained from a Consultant Virologist or Respiratory Physician.

4.4 Clusters of PVL-SA infection in the community

These can occur in various "social" groups, some of which are considered below.

4.4.1 Care homes and residential facilities, including prisons and barracks

Where there has been one case of PVL-SA-related infection enquiries should be made regarding other confirmed cases or recurrent septic lesions in residents and staff. The local Health Protection Unit (HPU) should be informed. A risk assessment should be performed to balance the number of cases of PVL-associated disease against the practicalities of screening all staff and residents. Individual cases may be suitable for topical decolonization. If a significant number (for example ≥ 4) of residents and staff are affected, an outbreak meeting should be arranged to discuss infection control issues and feasibility and practicalities of topical decolonization. A five-day course of therapy for all residents and staff is a significant undertaking and lack of compliance and acceptance are major issues where this has been tried. Furthermore, antiseptic washes may exacerbate pre-existing skin conditions and dermatological advice may be needed.

4.4.2 Nurseries and schools

The local HPU should be notified if there is suspicion of spread of PVL-associated infection in nurseries and schools. Screening of children and staff in a class may be warranted if there are two or more confirmed cases. Questioning may reveal a family/child with recurrent skin infections, e.g. boils, acting as the primary source. It is also important to establish that there are no children or staff with chronic skin conditions, such as eczema, acting as a continuing source. When screening

children, parental consent **will be required**, and nasal swabs should be collected, as well as swabs from the throat (if feasible) and skin lesions. Information about precautions to reduce the spread of PVL-SA is given in Appendix 4.

4.4.3 Gyms and sports facilities

The local HPU should be notified if there is suspicion of spread of PVL-SA-associated infection in sports facilities. A risk assessment should be performed to balance the number of cases of PVL-SA-associated disease against the practicalities of screening attendees and staff. Information about precautions to reduce the spread of PVL-SA is given in Appendix 3.

5. Infection prevention and control in hospital and the community

5.1 Infection prevention and control for hospitalised patients

Hospitals should have policies and procedures which deal with MRSA and these are generally appropriate for the control of PVL-SA. For advice about the control of MRSA see BSAC/HIS guidelines.³³ The following section reflects some of the important control measures.

5.1.1 Community-acquired infections

5.1.1.1 Skin and soft tissue infections (SSTIs)

The majority of patients admitted to hospital with PVL-SA will be admitted for incision and drainage of abscesses; a smaller number will be admitted with other SSTIs, such as cellulitis. The principles for MRSA prevention and control should be applied to those affected by PVL-SA (MSSA or MRSA). These include isolation in a single room, use of personal protective equipment (PPE) (most commonly plastic apron and gloves), meticulous hand hygiene, and environmental cleaning.

5.1.1.2 Necrotising pneumonia

Transmission of PVL-SA to staff has occurred following contact with respiratory secretions during intubation of a case of necrotising pneumonia where PPE was not worn.³⁴ Healthcare workers (HCWs) should wear PPE, including face and eye protection (e.g. surgical mask with integral eye protection), during intubation and respiratory care of a patient with possible necrotising pneumonia. HCWs in direct contact with respiratory secretions (particularly during intubation or mouth-to-mouth resuscitation from a PVL-positive patient) and who were not protected by appropriate PPE should be screened three to seven days after the exposure and advised to report to a physician should symptoms of infection present subsequently. Screening should be arranged through the occupational health department in liaison with the infection control team.

HCWs not in direct contact with respiratory secretions should not be screened.

5.1.2 Hospital-acquired infections

If a case of PVL-SA infection was acquired or possibly acquired in hospital, suitable investigations need to be undertaken. Screening other patients and staff

should be performed based on risk assessment and decolonization of positive individuals undertaken. Frequently, questioning patients and staff for previous individual and family history of recurrent skin infections identifies a potential source. The microbiology department should search its database for *S. aureus* infections with a similar antibiogram that may be related and any isolates, if still available, sent to the Staphylococcal Reference Unit for PVL-testing. This will help to ascertain any unidentified clusters of cases in the hospital.

5.1.3 Occupational Health

Occupational health departments in hospitals must be aware of this guidance.

In line with good infection control practice, HCWs should not work with infected skin or purulent eye lesions, and all cuts and grazes should be covered. All such lesions should be reported promptly to the Occupational Health Service.

A HCW with a proven PVL-SA infection should not work until the acute infection has resolved and 48 hours of a five day decolonization regimen has been completed. Enquiries regarding PVL-SA-related disease in close contacts of the staff member should be made, so that families can be treated simultaneously, if required.

Follow up screens following topical decolonization are advised as for MRSA guidelines (three screens one week apart). Unlike HA-MRSA, staff who are found to have PVL-SA are likely to have acquired the infection in the community, and hence re-colonization may occur from a close contact. Therefore, even if screens have been negative, staff should understand that they should stop working if a further skin lesion develops.

If, despite two courses of decolonization treatment, a staff member remains a carrier, they should be able to continue work providing they are not implicated in hospital transmission of PVL-SA infection and they cease working as soon as a possibly infected skin lesion develops.

5.2 Infection prevention and control for affected people in the community

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

- early suspicion of infection, with rapid diagnosis and appropriate treatment
- ensuring lesions are covered with clean, dry dressings, which are changed 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.

- ensuring laundry of towels, bedlinen, clothing etc using a hot wash (60°C), where possible
- regular household cleaning
- avoiding communal and recreational settings until lesions are healed if they cannot be adequately contained by a dressing; certain facilities such as gyms, saunas, swimming pools, those offering massage, manicure or similar, should be avoided until the lesions have healed.
- 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 be excluded from work until the lesions have healed.

These principles are addressed in more detail in Appendix 1.

6. Surveillance

Surveillance of PVL-SA is based currently on isolates referred to the Staphylococcal Reference Unit and shown to be PVL-positive. All *S. aureus* from suspected PVL cases and any PVL-positive strains identified locally should be sent to the Staphylococcal Reference Unit. A short questionnaire will then be sent to the requesting laboratory to ascertain basic clinical and epidemiological features. Comprehensive reporting of the clinical infections diagnosed as PVL-SA will enable the monitoring of the clinical impact of these strains in the general population and early warning of changing trends.

The Department of Health is sponsoring two major projects to determine the prevalence of PVL-SA in different settings. The first is to determine the proportion of SSTIs caused by PVL-SA among patients presenting to A&E departments. The second is a study of prevalence of nasal carriage in a random sample of people with no clinical symptoms related to *S. aureus* infection in Bristol, Gloucester and Devon. In addition, a small study is being undertaken in Devon to identify risk factors for PVL-SA infection.

PVL- Staphylococcus aureus Information for Patients

What is PVL Staphylococcus aureus?

Staphylococcus aureus ('SA') is a bacterium (germ) that commonly lives on healthy skin. About one third of healthy people carry it quite harmlessly, usually on moist surfaces such as the nostrils, armpits and groin. This is known as colonization. Some types of *Staphylococcus aureus* produce a toxin called Panton-Valentine Leukocidin (PVL) and they are known as PVL-SAs. (Panton and Valentine were two doctors who first found this chemical which can kill white blood cells called leukocytes – hence 'leukocidin').

What type of illness does it cause?

All SAs, including PVL-SAs, can cause harm if they get an opportunity to enter the body, for example through a cut or a graze. They can cause boils or skin abscesses and are occasionally associated with more serious infections of the lungs, blood, joints and bones.

Some SAs such as PVL-SA are more likely to cause infections than others.

How do you catch PVL-SA?

Anyone can get a PVL-SA infection. Infection can occur in fit, healthy people.

PVL-SA can be picked up by having:

- skin-to-skin contact with someone who is already infected, for example close family or during contact sports, or
- contact with an item or surface that has PVL-SA on it from someone else, for example shared gym equipment, shared razors, shared towels.

How is PVL-SA treated?

Boils and abscesses should be drained by incision by a doctor or nurse. Some infections may be treated with a course of antibiotics. In addition, the PVL-SAs carried on your skin may be eliminated with a five day skin treatment (washes, creams and shampoos). This is done to reduce the chances of you getting repeated infections and reduce the chances of you spreading PVL-SAs to others. In some patients this skin treatment may not be entirely successful, but the more carefully you follow the instructions, the more likely you are to clear the PVL-SAs from your skin. Your GP may recommend checking members of your household and close contacts, e.g. partners/children, in case they are also carrying PVL-SAs, and offering them skin treatments where necessary.

How do I prevent passing PVL-SAs to other people?

- You need to keep infected areas of your body covered with clean, dry dressings or plasters. Change these regularly and as soon as discharge seeps to the surface. It is important that fluid or pus from infected skin is

contained, because it has large numbers of PVL-SAs that can spread to others.

- Do not touch, poke or squeeze infected skin. This contaminates your hands and can push the PVL-SAs deeper into the skin. Contact your GP surgery if you have a boil or abscess that needs draining.
- Cover your nose and mouth with a tissue when you cough or sneeze, particularly if you have a cold, because PVL-SAs can live in your nose. Throw the tissue in the bin at once and then wash your hands.
- Wash your hands frequently with liquid soap and water, and **especially** after changing your plasters, dressings, and bandages or touching infected skin.
- Encourage others at home to wash their hands regularly with liquid soap.
- Use a separate towel and keep it separately, so others don't use it by mistake. Have it washed frequently in a hot wash.
- Regularly vacuum and dust (wiping with a damp cloth) your bedroom, bathroom, kitchen and other rooms, as well as personal items and shared items, such as keyboards. Household detergent is adequate for cleaning.
- Clean your sink, taps and bath after use with a disposable cloth and household detergent, then rinse clean and throw away the cloth.

Can I go to work or school when I have a PVL- SA 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 or GP.
- 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 your GP.
- Children can only 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 who have eczema or a more generalised skin condition should remain off work or school until treatment has been completed for both the eczema or skin condition and the PVL-SA infection. 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-SA to others.

Can I go to swimming pools, gyms or sports facilities when I have a PVL-SA 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?

- You should take good care of your skin. If you suffer from eczema, discuss the best treatment for this with your GP
- Keep all cuts and grazes clean with liquid soap and water, apply disinfectant cream, and cover with dry dressings until scabbed over or healed
- Shower or bathe daily
- Put on clean clothes daily and wash bedclothes and towels on a regular basis using normal washing detergent but at the highest temperature the materials will allow
- Do not share personal items such as towels, razors, toothbrushes, water bottles, and facecloths
- In shared facilities, such as gyms, use fresh towels. Only go when skin lesions have healed and put a towel between your skin and the equipment. Importantly, shower afterwards and use a separate (second) clean towel to dry yourself. Wash any towels which you have taken to shared facilities after each visit
- Seek medical help at the first sign of infection in a cut, such as redness, swelling, pain, or pus
- If you are found to carry PVL-SA persistently on your skin or nose, or if you suffer from repeated infections, you may be prescribed a further course of skin treatment. If this fails to eliminate it and you suffer repeated infections then you may be prescribed antibiotics and skin treatment together. 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-SA infection. This will ensure that you receive appropriate treatment.

Appendix 2

Decolonization procedure for *PVL-Staphylococcus aureus*: how to use the decolonization preparations

The purpose of decolonization is to try to rid the body of the bacteria that have caused boils or other infections. Preparations must be used as detailed below.

General notes on skin treatment

As with all treatments to be applied to the skin, avoid contact with the eyes. Those who are pregnant, have eczema, or are under a year old should be screened first to see if they are carrying the bacteria (the doctor or nurse who is arranging your treatment will explain how this is done). The doctor will then decide whether treatment is appropriate. This treatment should not be used if there are any boils or skin lesions that are still leaking. Wait until boils or lesions are dry. Whilst the skin treatments are being used the following will help reduce spread of the bacteria within the care home or household:

- Sheets/towels should be changed daily
- Regular vacuuming and dusting, particularly the bedrooms
- If possible avoid bar soap and use pump action liquid soap
- Use individual personal towels and facecloths. Wash them frequently in a hot wash.
- Clean sink and bath with a disposable cloth and detergent after use, and then rinse clean

Chlorhexidine 4% bodywash/shampoo or Triclosan 2% use once a day for 5 days:

- Use daily as liquid soap in the bath, shower or bowl and as a shampoo on days 1, 3 and 5
- Do **NOT** dilute it beforehand in water as this will reduce its efficacy — apply directly to wet skin on a disposable wipe or on hand
- Do not use regular soap in addition during baths/showers
- Do **NOT** apply to dry skin
- Pay particular attention to armpits, groins, under breasts, hands and buttocks
- It should remain in contact with the skin for about a minute

- Rinse off well before drying skin thoroughly. This is particularly important in people with skin conditions (e.g. eczema).
- Towels should be for individual person use and, if possible, changed daily

Mupirocin (Bactroban Nasal) (use three times a day for 5 days):

- Apply a matchstick head-sized amount (less for a small child) on the end of a cotton bud to the inner surface of each nostril. Press the sides of the nose together and massage gently to spread the ointment inside the nostrils.

Sometimes you might also be asked to gargle with an antiseptic solution.

For individual concerns or further advice please contact your GP or your local Health Protection Unit.

Guidance for reducing the spread of PVL-Staphylococcus aureus in communal and other recreational settings

1. What is PVL-Staphylococcus aureus?

Staphylococcus aureus (SA) is a type of bacterium (germ) commonly found living on healthy skin. It particularly likes moist surfaces of the body, such as the nostrils, armpits and groin. People carry many different strains of SA, some causing more infections than others. Some strains can produce the Panton-Valentine Leukocidin (PVL) toxin. (Panton and Valentine were two doctors who first found this chemical which can kill white blood cells – hence 'leukocidin'). These strains commonly cause boils or skin abscesses and are occasionally associated with more serious infections of the lungs, blood, joints and bones. Some strains of methicillin-resistant *Staphylococcus aureus* (MRSA) present in the community can also produce PVL toxin.

2. Standard precautions including handwashing and general hygiene

Management are responsible for ensuring basic training for staff in hygiene, and maintenance of equipment. While on the premises staff, clients or visitors should follow the establishment's procedure on infection control. All premises should be encouraged to have a policy which includes a statement that individuals with boils, open sores or cuts which cannot be contained by a dressing should be excluded until the wound has healed.

- The establishment should ensure that access to basic handwashing facilities is provided. Pump action liquid soap, warm running water and paper handtowels are recommended. Where hand towels are not available, hot air dryers can be used;
- It is the responsibility of each individual using the premises to ensure that they use the handwashing facilities before entering and when leaving, or any time when hands are visibly soiled;
- Staff must keep skin lesions (e.g. boils, open sores, or cuts) covered with a clean dry dressing. If fluid seeps through the dressing and it cannot be contained, exclusion of the individual is advised until the wound has healed and treatment or decolonization has begun;
- Personal items (e.g. towels, robes etc) should not be shared; they can be used by others only *after* laundering;
- Soap, razors, toothbrushes and water bottles should never be shared;
- A barrier (e.g. a towel or a layer of clothing) between the skin and shared equipment should be used;

- If there has been substantial skin-to-skin contact with another person or communal gym equipment has been used, users should take a shower.

Shared equipment (e.g. exercise machines)

While using shared equipment on the premises, users should be encouraged to:

- Use a towel or clothing to act as a barrier between surfaces of shared equipment and bare skin;
- Wipe surfaces of equipment with disinfectant *before* and *after* use, especially if the surface has become wet with sweat.

Staff should be encouraged to:

- Provide hard surface detergent wipes for users of the equipment and encourage use *before* using equipment;
- Check with equipment manufacturers for recommendations on the appropriate cleaning and disinfection of their products;
- Clean shared equipment surfaces at least daily and when visibly soiled;
- Disinfect shared equipment surfaces with a detergent disinfectant according to manufacturer's instructions; Management should ensure that staff have access to good standard detergent for cleaning;
- Repair or dispose of equipment and furniture with damaged surfaces that cannot be adequately cleaned. Frayed and damaged surfaces are an infection risk; proper upkeep of equipment is critical to prevent spread of infection;
- Ensure that there is a policy for regular environmental cleaning;
- Managers should ensure staff receive appropriate training in general cleaning of the equipment and the environment.

3. Steam rooms, saunas and pools

While using these facilities, users should be encouraged to

- Use a towel or clothing to act as a barrier between the benches and bare skin;
- Shower before and after use of the facilities.

Staff should be encouraged to:

- Clean and disinfect frequently used surfaces at least daily or when visibly soiled;
- Consider painting wood benches with a non-slip water-proof paint or varnish to seal and smooth the surface, facilitate drying, and reduce areas where bacteria may grow;
- Use a recommended disinfectant (e.g. chlorine or other halides) for swimming pools, spa pools and other basins or tanks used for immersion by multiple patrons;
- Ensure spa pools used for single-use immersion are flushed through, cleaned and rinsed after each user, using the recommended disinfectant;
- For non-porous surfaces (e.g. tile, stainless steel, epoxy, and linoleum), ensure a detergent disinfectant suitable for the type of surface being treated is used. A dilution of household chlorine bleach may be suitable, according to manufacturer's instructions;
- For wood surfaces, scrub and disinfect with a dilution of household chlorine bleach according to manufacturer's instructions. Bleach solutions should be left on surfaces for at least 10 minutes to achieve maximum disinfection;
- If bleach is used, cleaning and disinfection should be done at room temperature and surfaces should be rinsed well before re-starting the heat to prevent breathing difficulties and irritation of the eyes.

4. Laundry

Staff in facility laundries should be encouraged to:

- Wash shared linens (e.g. towels, sheets, blankets, or uniforms) using a hot wash (60°C) where possible;
- Use laundry detergents according to the manufacturer's instructions;
- Distribute towels, uniforms, etc. only when they are completely dry;
- Wash hands after handling dirty laundry.

5. Use of disinfectants on surfaces

- Staff should be fully trained in disinfectant use;
- Check the product's label to ensure that the disinfectant is suitable for the

type of surface being treated (e.g. vinyl, cloth, plastic or wood);

- Ensure that the disinfectant is diluted to the correct strength and that this working solution remains on the surface of the equipment for the recommended contact time and it is rinsed off thoroughly after cleaning;
- Unused working solutions of disinfectant should not be stored for later use; they can be poured down the drain. Disposable wipe cloths can be discarded as a routine solid waste;
- If a bleach-based solution is used, it must only be used on appropriate surfaces to reduce risk of damage to equipment and other surfaces. It must be diluted correctly and must be rinsed off thoroughly afterwards.

Further Reading

Infection Control Nurses Association (2002). Hand decontamination guidelines. Bathgate ICNA.

Management of spa pools: Controlling the risk of infection. London: Health Protection Agency, March 2006.

Appendix 4

Guidance for reducing the spread of PVL-Staphylococcus aureus (PVL-SA) in schools and nurseries

4.1 General Measures

1. Hand hygiene should be facilitated by providing adequate washing facilities and supplies. Liquid soap dispensers (not soap bars) should be used and paper towel dispensers should replace cloth towels.
2. Children should wash hands after using toilets, before eating and drinking, before and after use of the gymnasium and other communal sports activities, and whenever hands are contaminated or soiled.
3. Open wounds should be covered with a clean, dry occlusive dressing.
4. Children and staff with uncontained wound drainage should be excluded from school and must not participate in sports until their wound is no longer draining (see below).
5. Contaminated surfaces should be cleaned promptly with detergent and water.
6. Common areas in school/nursery (e.g. toilets, locker rooms, dining room etc), should be kept clean by following regularly scheduled cleaning protocols.

4.2 For individual cases with PVL-SA infection

1. Individuals can go to school provided they feel well, are of an age where they can understand the importance of good hand hygiene, and the infected skin is covered with a clean dry dressing able to stay dry and in place until the end of the school day.
2. Individuals should not be at school if they have a boil that requires drainage or a newly discharging boil or abscess, the leakage from which cannot easily be contained.
3. Individuals must be given a patient information sheet outlining precautions they should take to avoid infecting others (example in Appendix 1).
4. Individuals should not take part in contact sports or use communal gym equipment until their skin lesion has totally healed.
5. Those with eczema or a more generalised skin condition should remain off school until treatment has been optimised and a course of decolonization has been completed. Treating the skin condition is essential if decolonization is to be successful. Maintaining optimal treatment for the skin condition in the long term will reduce the risk of spread of PVL-SA to others.

4.3 Increasing numbers of skin infections

If it appears that infection is spreading between children, the local Health Protection Unit should be contacted.

(Contact details available at:

<http://www.hpa.org.uk/web/HPAweb&Page&HPAwebAutoListName/Page/1158945066055>).

Appendix 5

Advice for managers of care homes to help reduce spread of PVL-Staphylococcus aureus

5.1 Standard Infection Control Precautions

All personnel involved in providing care should be trained in Standard Principles for Infection Control.¹ These are divided into three broad categories:

- Hand hygiene
- Personal Protective Equipment (PPE)
- Safe use and disposal of sharp instruments

In any environment that delivers care, staff must be trained in the Standard Principles for Infection Control. In an environment where one (or more) individual has a confirmed or suspected PVL-SA lesion, these principles must be reinforced to reduce the potential for further spread and outbreak among residents and staff. Staff should be asked to report any skin or eye lesions.

If it appears that infection is spreading, the local Health Protection Unit should be contacted.

(Contact details available at:

<http://www.hpa.org.uk/web/HPAweb&Page&HPAwebAutoListName/Page/1158945066055>).

Hand hygiene is the single most important activity for reducing the transmission of micro-organisms from one area of the body to another and subsequently to other residents and staff. The establishment **must** provide sufficient quantities of liquid soap, hot and cold running water and paper towels. Hands should be washed before and after every individual client activity, taking particular care when in contact with blood, bloodstained body fluids, pus, or other secretions. Hands must be washed when visibly soiled.

Personal Protective Equipment includes disposable gloves and aprons, mask, goggles. A risk assessment of the action to be undertaken should be carried out by the staff member involved to identify what is required. In most settings this will be gloves (appropriate to procedure) and an apron.

Aprons are a single use item and should be worn for all direct patient care including bed making, cleaning equipment following use, and when there is a risk of contamination of staff clothing. Aprons must be used for one procedure or activity only and then disposed of as clinical waste and hands washed afterwards.

Gloves are not a substitute for hand washing and should also be used for one activity only and then be disposed of as clinical waste and hands must then be washed. Staff members should ensure that they have risk assessed the activity and have well-fitting gloves appropriate for the activity.

5.2 Environment and General Cleaning

All care facilities should be cleaned to the highest possible standard.

A clear and specific plan should be set to identify the cleaning service, detailing what needs to be cleaned, how it should be cleaned, frequency of cleaning and the roles and responsibilities of those involved. This should incorporate plans for dealing with an outbreak or significant risk of infection. This plan should also clearly identify procedures for terminal cleaning (i.e. a thorough clean when a room has been vacated by an infected person), which may include the employment of outside contractors.

Staff employed to provide an environmental cleaning service **must** have had training and education to provide the best possible outcome. It is the individual's responsibility to take up this training but the home manager and the registered owner **MUST** make this available.

5.3 Laundry Facilities

A designated laundry area should be made available for the laundry process, which should include two doors, an entrance for soiled linen and an exit for the clean linen.

An industrial washing machine and dryer should be installed and a maintenance contract agreed to ensure effective decontamination of linen.

Personal Protective Equipment should be made available for laundry staff. A hand wash basin, pump action soap and disposable paper towels must be available within the laundry along with a pedal-operated bin.

Manual sluicing should not be undertaken. Contaminated or infected linen should be taken from the individual and bagged in water soluble liners which are transferred directly to the laundry. A coding system for categories of laundry should be in place.

If possible, staff uniforms should be laundered on site. Where this is not possible, staff should be advised to launder their uniforms at no less than 60°C. Staff should, where possible, be allocated changing rooms and change into their uniform at the beginning of the shift and out of their uniform at the end of the shift. A clean uniform should be worn for each shift. ²

Further Reading

1. Infection Control Guidance for Care Homes. Department of Health, London 2006
2. Wilson JA, Loveday HP, Hoffman PN, Pratt RJ. Uniform: an evidence based review of the microbiology significance of uniforms and uniform policy in the prevention and control of healthcare-associated infections. Report to the Department of Health (England). *J Hosp Infect* 2007; **66**: 301-307

Diagnosis and Management of PVL-*Staphylococcus aureus* Infections

Quick Reference Guide for Primary Care⁽¹⁾

- Panton-Valentine Leukocidin (PVL) is a toxin produced by less than 2% of *S. aureus*, including MRSA^(1,2).
- PVL-SA cause recurrent skin and soft tissue infections, but can also cause invasive infections, including necrotising haemorrhagic pneumonia in otherwise healthy young people in the community.

CHARACTERISTICS OF INFECTIONS WITH PVL¹⁻³

Recurrent skin infections:

- Boils (furunculosis), carbuncles, folliculitis, cellulitis
- Cutaneous lesions can be >5cm
- Pain/erythema out of proportion to severity of signs
- With necrosis

Invasive infections:

- Necrotising pneumonia often after flu-like illness
- Necrotising fasciitis
- Osteomyelitis, septic arthritis and pyomyositis
- Purpura fulminans⁽³⁾

RISK FACTORS & GROUPS^{3,4}

Risk factors: Remember the “5 Cs”;

- Contaminated items shared – eg: towels, razors
- Close contact
- Crowding
- Cleanliness: poor hygiene
- Cuts and other compromised skin integrity

Risk groups often young and healthy :

- Closed communities with close contact
- Close contact sports eg: wrestling, rugby, judo
- Military training camps
- Gyms
- Prisons

WHEN AND HOW SHOULD I INVESTIGATE FOR PVL *S. aureus*?⁵

When should I take a specimen?

- Recurrent boils/abscesses
 - Necrotising skin and soft tissue infections
 - If ≥ 1 case in a home or closed community
- Community-acquired necrotising/haemorrhagic pneumonia:
sputum and swabs & refer immediately
On form state risk factors and request PVL.

Swab

What swabs should I take?

- Skin lesions & anterior nares
- Use swab moistened with water or saline
- Place swab in transport medium

How should I take an anterior nares swab?

- Wipe a moistened swab around inside rim of both nostrils of the patient for 5 seconds

HOW CAN PATIENTS REDUCE SPREAD IN CARE HOMES OR HOUSEHOLDS?

- Cover infected skin with dressing, change regularly
- Do not touch or squeeze skin lesions
- Regularly wash hands
- Avoid bar soap; use pump action liquid soap
- Clean sink and bath after use with a disposable cloth and detergent, and then rinse clean
- Cough or sneeze into a tissue then wash hands after immediate disposal.
- Use individual personal towels and face cloths, washing daily in hot wash, or use paper towels.
- Regularly vacuum & damp dust, especially bedrooms
- If colonisation persists consider further treatment and hygiene measures eg. change sheets daily

WHEN AND HOW DO I TREAT WITH ANTIBIOTICS?^{1,3}

This advice is mainly based on clinical outcome in the treatment of non-PVL-MRSA.
 If immunocompromised or deteriorating clinically seek advice

Infection	*Antibiotic ⁶	Adult Dosage	Duration
Minor furunculosis, folliculitis and small abscesses without cellulitis	NO antibiotics; Perform incision and drainage if necessary		
Other non-suppurative minor skin & soft tissue infections. As resistance is increasing reserve topical antibiotics for very localised lesions. Only use mupirocin for MRSA.	Flucloxacillin	Oral 500 mg qds	5-7days
	<i>Fusidic acid</i> } <i>Second line</i> <i>Mupirocin</i> }	<i>Topically tds</i>	<i>5 days</i>
Moderate SSTIs eg cellulitis or abscesses >5cm with <u>Meticillin-sensitive</u> PVL	Flucloxacillin or Clindamycin – <i>stop if diarrhoea develops</i>	500 mg qds 450 mg qds	5-7days
If PVL is likely to be MRSA Treat empirically with 2 agents and then be guided by antibiotic susceptibility results.	Rifampicin PLUS Doxycycline (not children) or Sodium fusidate or Trimethoprim	300 mg bd 100 mg bd 500 mg tds 200 mg bd	5-7days
On advice of microbiologist/hospital	OR Clindamycin alone <i>Third line</i> Linezolid	450 mg qds 600 mg bd	
Severe SSTIs with systemic symptoms or pneumonia.	Refer immediately		

WHEN SHOULD I ADVISE SUPPRESSION OF PVL IN PATIENTS AND THEIR CLOSE CONTACTS?

- When considering decolonization of patients and close contacts, discuss risk factors, risk groups, employment settings and compliance with Health Protection Unit/Microbiology.
- Offer decolonisation to all primary cases.
- Suppression of PVL is ineffective if skin lesions still leaking.
- Start suppression after primary infection resolved.

5 DAY TOPICAL TREATMENT PROCEDURE FOR SUPPRESSION OF PVL-STAPHYLOCOCCUS AUREUS⁷

Topical treatment aims to reduce colonisation and may prevent further infections and interrupt transmission
A patient information leaflet is available at ([Patient leaflet](#))^{8,9}

BODY¹⁰

Use Chlorhexidine 4% bodywash/shampoo or Triclosan 1 - 2% (Skinsan or Oilatum Plus). Use daily as liquid soap in the bath, shower or bowl for 5 days. Use as a shampoo on day 1, day 3 and day 5

- Do NOT dilute product in water as this reduces efficacy
- Apply product directly to wet skin as soap on a disposable cloth or on hand
- Do NOT use other bath soap/shower gel in addition during baths/showers
- Pay particular attention to armpits, groins, under breasts, hands and buttocks
- It should remain in contact with the skin for about a minute
- Rinse off before drying thoroughly, especially if skin conditions
- Patients with skin conditions/delicate skin – Dermal should be considered
- Dermatological opinion may be necessary in patients with skin conditions eg eczema.

NOSE¹⁰

- Use matchstick head-sized amount (less for small child) of Mupirocin.
- Apply 3 times day for 5 days with cotton bud to inner surface of each nostril.
- Massage gently upwards.
- If applied correctly, patient can taste Mupirocin at back of throat.

FOLLOW-UP

- Advise patient to return if infection persists or recurs.
- Patients with recurrent infections or persistent colonization should maintain sensible precautions to prevent transmission (as outlined above) [Appendix 1](#)
- Only undertake repeated screening/decolonization if patient:
 - immunosuppressed
 - poses a special risk to others (e.g. healthcare worker, carer, food handler)
 - spread of infection is ongoing in close contacts. [Guidance](#)

WHO AND WHEN SHOULD I INFORM ABOUT A CASE OF PVL?

WHO

- The local Health Protection Unit
Tel:
- Inform hospital before any admissions

WHEN

- Where there has been one case of PVL-related infection in a closed community.
- Suspicion of spread of PVL-associated infection in families, nurseries, schools and sports facilities

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Special consideration of infections in children

Appendix 7

	Skin and Soft Tissue	Bone and Joint	Severe Sepsis	Pneumonia
Suggestive Clinical Features	<p>Recurrent furunculosis or abscesses</p> <p>Close contacts with skin lesions in child or other family members</p>	<p>Close contacts with skin lesions in child or other family members</p> <p>Associated severe sepsis</p> <p>Multiple sites of infection / metastatic abscesses</p> <p>Locally extensive infection</p> <p>Associated myositis / Pyomyositis</p> <p>Locally associated venous thrombosis</p> <p>Very high CRP</p> <p>Need for repeated surgical intervention</p>	<p>Close contacts with skin lesions in child or other family members</p> <p>Associated with bone or joint infection</p> <p>Associated with necrotising pneumonia</p> <p>Associated with recurrent furunculosis or abscesses</p> <p>Associated with deep venous thrombosis</p> <p>Associated with pupura fulminans</p>	<p>Close contacts with skin lesions in child or other family members</p> <p>Preceding "flu-like" illness</p> <p>Associated with severe sepsis</p> <p>Associated with bone or joint infection</p> <p>Associated with recurrent furunculosis or abscesses</p> <p>Haemoptysis</p> <p>Multilobular infiltrates and pleural effusions</p> <p>Leucopenia / neutropaenia</p>
First Line – Empiric Antibiotic Therapy*	<p>If possible await results of culture and sensitivities before commencing antibiotics</p> <p>If there is a clinical need to treat empirically follow local guideline for treatment of skin and soft tissue infection</p> <p>Manage severe infections as for severe sepsis</p>	<p>Follow local antibiotic guidelines for the specific type of infection</p> <p>ADD Clindamycin if there are any features suggestive of PVL-SA</p> <p>ADD Linezolid if MRSA is suspected based on contact history, travel history or failure to respond to treatment, or once PVL status is confirmed</p>		
First Line – Other Empiric Management	<p>Incision and drainage of abscesses</p> <p>Standard and contact precautions Discuss need for isolation with infection control team</p> <p>Decontamination for child and contacts</p>	<p>Resuscitation and stabilisation following APLS guidelines</p> <p>Aggressive early orthopaedic intervention to drain focus of infection</p> <p>Consider thromboembolism prophylaxis</p> <p>Standard and contact precautions Discuss need for isolation with infection control team</p> <p>Decontamination for child and contacts</p>	<p>Resuscitation and stabilisation following APLS guidelines</p> <p>Early discussion and transfer to Paediatric Intensive Care Unit</p> <p>Administer IVIG 1-2g/kg initial dose, repeated after 24-48 hours at lower dose if necessary</p> <p>Consider thromboembolism prophylaxis</p> <p>Standard and contact precautions Discuss need for isolation with infection control team</p> <p>Decontamination for child and contacts</p>	<p>Resuscitation and stabilisation following APLS guidelines</p> <p>Early discussion and transfer to Paediatric Intensive Care Unit</p> <p>Administer IVIG 1-2g/kg initial dose, repeated after 24-48 hours at lower dose if necessary</p> <p>Consider thromboembolism prophylaxis</p> <p>Standard and respiratory precautions Discuss need for isolation with infection control team</p> <p>Decontamination for child and contacts</p>

<p>Investigations</p>	<p>Send swabs and pus specimens for culture and sensitivity</p>	<p>Blood culture</p> <p>Microscopy and culture of bone and joint specimens, and swabs from any skin lesions</p> <p>Serial MRI scans to determine extent of local disease and response to treatment</p> <p>Radioisotope scan to determine metastatic sites of infection which may not be clinically apparent</p> <p>Additional imaging for metastatic sites of infection if there is failure to respond to initial management</p> <p>Assessment for occult deep vein thrombosis</p>	<p>Blood culture</p> <p>Microscopy and culture of swabs from any skin lesions</p> <p>Imaging for foci of infection, particularly clinically occult bone and joint infection</p> <p>Assessment for occult deep vein thrombosis</p>	<p>Blood culture</p> <p>Microscopy and culture of sputum / tracheal secretions / bronchoalveolar lavage</p> <p>Investigations for influenza A (using nasopharyngeal aspirate / tracheal secretions / bronchoalveolar lavage fluid)</p> <p>Assessment for occult deep vein thrombosis</p>
<p>Rationalisation of Antibiotic Therapy once PVL status is confirmed*and antibiotic sensitivities are known</p>	<p>Guided by antibiotic sensitivity profile, and acceptability of antibiotic regimen</p>	<p>Guided by antibiotic sensitivity profile of organism</p> <p><u>Initial Phase of treatment:</u> Intravenous Clindamycin <i>plus</i> linezolid <i>plus</i> rifampicin until inflammatory markers return to normal and infection is controlled (absolute maximum of 4-weeks of linezolid treatment, ideally only 2-3 weeks)</p> <p><u>Continuation phase of treatment:</u> IV / Oral Clindamycin <i>plus</i> rifampicin, duration & route directed by a specialist in Paediatric Infectious Diseases</p>	<p>Guided by antibiotic sensitivity profile of organism</p> <p>If clindamycin sensitive, use clindamycin plus rifampicin +/- linezolid; if resistant, use linezolid plus rifampicin</p>	<p>Guided by antibiotic sensitivity profile of organism</p> <p>If clindamycin sensitive, use clindamycin plus rifampicin +/- linezolid; if resistant, use linezolid plus rifampicin</p>
<p>Other Definitive Management</p>		<p>Repeated surgical intervention to drain / remove foci of infection may be required</p>	<p>Surgical intervention to drain / remove foci of infection may be required</p>	<p>Surgical intervention to drain / remove foci of infection may be required</p>
<p>Consultations</p>	<p>Local microbiologist</p> <p>Surgeon / Paediatric Surgeon</p>	<p>Orthopaedic Surgeon with Paediatric expertise</p> <p>Paediatric Infectious Diseases Specialist</p> <p>Paediatric Intensive Care Unit</p> <p>Microbiologist</p> <p>Haematologist with Paediatric Expertise</p>	<p>Paediatric Infectious Diseases Specialist</p> <p>Paediatric Intensive Care Unit</p> <p>Microbiologist</p> <p>Surgeon with Paediatric Expertise</p> <p>Haematologist with Paediatric Expertise</p>	<p>Paediatric Infectious Diseases Specialist</p> <p>Paediatric Intensive Care Unit</p> <p>Microbiologist</p> <p>Surgeon with Paediatric Expertise</p> <p>Haematologist with Paediatric Expertise</p>
<p>Screening and decolonization</p>	<p>Follow recommendations in section 4</p>			

* Antibiotic doses should follow the recommendations in the British National Formulary for Children (use the **highest** recommended IV doses for severe infections).

Membership of the sub-group

The sub-group was convened by the Steering Group on Healthcare Associated Infection in December 2006 and comprised the following members:

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Equality Impact Assessment

This guidance aims to improve practice and consequently patient care and outcomes. As part of standard practice, we considered the need for an equality impact assessment. We are not aware of any evidence that different groups have different priorities in relation to PVL, or that any group is affected disproportionately or any evidence or concern that this guidance may discriminate against a particular population group. Thus, we decided that an equality impact assessment was not required.

Glossary

A&E	Accident & Emergency Department
APLS	Advanced Paediatric Life Support
BNF	British National Formulary
BNFc	British National Formulary for children
BSAC	British Society for Antimicrobial Chemotherapy
CA-MRSA	Community-associated meticillin-resistant <i>Staphylococcus aureus</i>
CAP	Community-acquired pneumonia
CRP	C- Reactive Protein
CURB65	a score for assessing the severity of illness in patients with pneumonia - each risk factor scores one point, for a maximum score of 5: C onfusion; U rea greater than 7 mmol/l; R espiratory rate of 30 breaths per minute or greater; B lood pressure less than 90 systolic or diastolic blood pressure 60 or less; age 65 or older
EMRSA	Epidemic meticillin-resistant <i>Staphylococcus aureus</i>
ESR	Erythrocyte Sedimentation Rate
GP	General Practitioner
HA-MRSA	Hospital-associated meticillin-resistant <i>Staphylococcus aureus</i>
HCW	Healthcare worker
HIS	Hospital Infection Society
HPU	Health Protection Unit - contactable via http://www.hpa.org.uk/web/HPAweb&Page&HPAwebAutoListName/Page/1158945066055
ICU	Intensive Care Unit
IV	Intravenous
IVIG	Intravenous immunoglobulin
MIC	Minimum inhibitory concentration
MRI	Magnetic Resonance Imaging

MRSA	Meticillin-resistant <i>Staphylococcus aureus</i>
MSSA	Meticillin-sensitive <i>Staphylococcus aureus</i>
NPA	Nasopharyngeal aspirate
PE	Pulmonary embolus
PPE	Personal protective equipment
PVL	Panton-Valentine Leukocidin
SA	<i>Staphylococcus aureus</i>
SSTI	Skin and soft tissue infection
TSS	Toxic shock syndrome

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