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

DH Department of Health

Health Protection Agency

This guidance was prepared by a subgroup of the Steering Group on Healthcare Associated Infections (SG-HCAI) at the request of the Department of Health and replaces the guidance that was drafted by a working group of the Health Protection Agency (HPA) in 2006.

This guidance is based on a review of the literature and experiences of colleagues in the UK, Europe, the USA and Canada. There is little research evidence to support this guidance which is intended to be updated on a regular basis, as and when developments in the field dictate.

This guidance is intended to provide healthcare professionals with easily accessible advice on the recognition, investigation and management of PVL-SA cases. More detailed guidance on the diagnosis and principles of management of MRSA infections presenting in the community has been produced by the British Society for Antimicrobial Chemotherapy (BSAC) at the request of the Specialist Advisory Committee on Antimicrobial Resistance (SACAR) and there has been close collaboration between the subgroups.

1. Background

Panton-Valentine Leukocidin (PVL) is a toxin which destroys white blood cells and is a virulence factor in some strains of *Staphylococcus aureus.* Strains of *S. aureus* producing a new pattern of disease have emerged in the UK and world-wide. In the UK the genes encoding for PVL are carried by less than 2% of clinical isolates of *S. aureus* whether meticillin-sensitive (MSSA) or meticillin-resistant (MRSA) (1). To date the majority of PVL – positive strains in the UK have been MSSA, but in North America, in particular, a major problem has emerged with community-associated strains of MRSA (CA-MRSA), most of which produce PVL. One strain in particular, the so-called USA300 clone, is now spreading in hospitals in the USA. Hence there is a need to keep the situation in the UK under regular review.

1.1 Clinical features of PVL–SA

In common with *S. aureus* infections in general, PVL-SA predominantly cause skin and soft tissue infections, but can also cause invasive infections, the most serious of which is a necrotising haemorrhagic pneumonia with a high mortality, and often follows a flu-like illness. It may affect otherwise healthy young people in the community.

1.2 Skin and soft tissue infections (SSTI)

These are often recurrent and can comprise:

- Boils (furunculosis), carbuncles, folliculitis, cellulitis
- Cutaneous lesions 5cm or larger in diameter are not uncommon
- Pain and erythema that seem out of proportion to severity of cutaneous findings may occur
- Necrosis is an indicator of possible PVL-SA infection

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. It is not known what percentage are genuinely of viral aetiology. It is recommended that co-infection with a respiratory virus, including influenza A is investigated.

1.4 Risk factors for PVL-SA

The risk factors for PVL-SA seen in the UK are likely to correspond to those described for CA-MRSA in North America. In general, these include situations in which there is compromised skin integrity, skin to skin contact, and sharing of contaminated items. Worldwide experience suggests that closed communities with people in close contact with each other are higher risk settings for transmission of staphylococcal infections.

In the North American experience, the following settings have been identified as higher risk for transmission if an individual is colonised or infected with CA-MRSA.

- households
- close contact sports such as wrestling, American football, rugby, judo
- military training camps
- gyms
- prisons

CDC guidance refers to the "5 C's" of risk factors for PVL-related infection and is a useful aide memoir: 1) Contaminated items; 2) Close contact; 3) Crowding; 4) Cleanliness; 5) Cuts and other compromised skin integrity (2)

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

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

Hospital associated–MRSA	Community associated–MRSA**
Typical patients	
Elderly, debilitated and /or critically or chronically ill	Young, healthy people; students professional athletes and military service personnel
Infection site	
Often cause bacteraemia	Predilection for skin: cellulitis, abscess
Transmission	
Within healthcare settings, little spread among household contacts	Community–acquired. May spread in close community settings e.g. families and sports teams
Diagnosis is typically made	
In an inpatient setting	In an outpatient setting
Medical history	
History of MRSA colonisation, infection, recent surgery; admission to a hospital or nursing homes, antibiotic use; dialysis, permanent indwelling catheter	No significant medical history
Virulence factors	
Community spread is limited. PVL genes are absent	Community spread can occur easily PVL genes present, predisposing to necrotising soft tissue infection.
Antibiotic susceptibility	
Choice of agents is often more limited.	Currently more susceptible to more antibiotics than HA-MRSA

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

**** This is an evolving situation and CA-MRSA has caused hospital acquired MRSA infections in some countries. This has also occurred in the UK, hence the need for vigilance. More resistant CA-MRSA are emerging in some parts of world and so distinguishing these from HA-MRSA can be more problematic.**

1.5 When to suspect PVL-SA infection

PVL-associated staphylococcal infection should be suspected if an individual patient has a necrotising skin or soft tissue infection, recurrent furunculosis or abscesses, or there is clustering of SSTIs within a household or social group. It should also be suspected in cases of invasive infection in immunocompetent people, particularly community-acquired necrotising/haemorrhagic pneumonia in the young.

2. Microbiological Sampling

Figure 1 shows an algorithm for the appropriate testing of specimens in suspected PVL-related disease.

PVL genes can be carried by both MSSA and MRSA. PVL-positive MSSA's display variable antimicrobial susceptibility profiles which can be geographically distinct. Whilst currently the vast majority of PVL-positive MRSA found in the UK are susceptible to ciprofloxacin, resistance is emerging in some strains isolated from patients returning from USA. Ciprofloxacin resistant MRSA should not be referred to the Staphylococcus Reference Laboratory for PVL testing unless they are associated with typical PVL disease (see Figure 1).

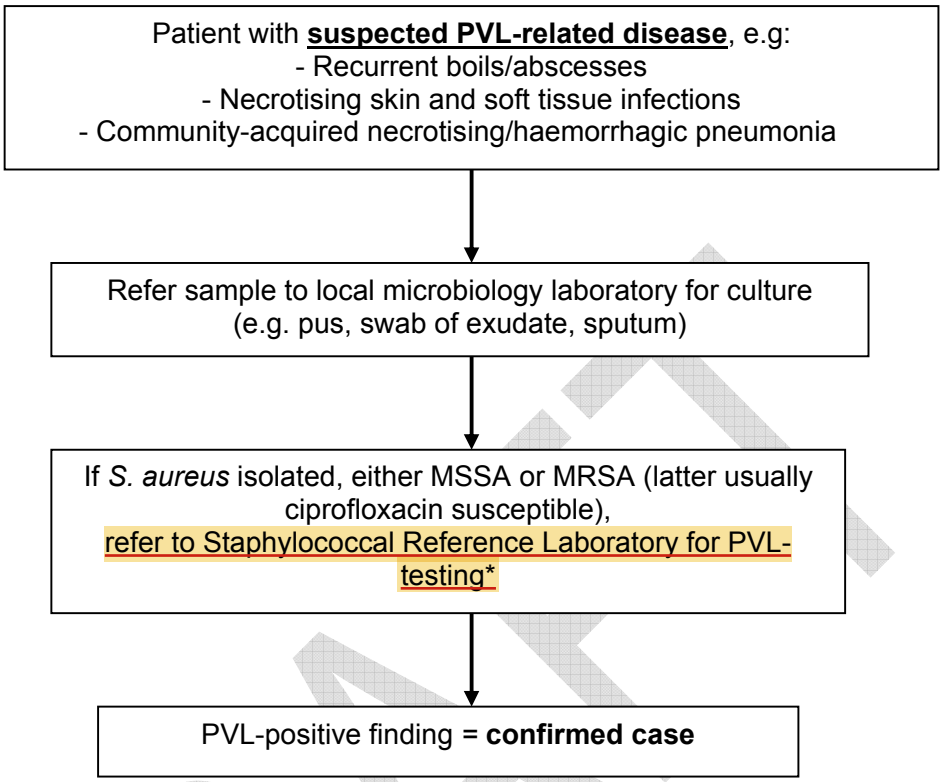
2.1 Microbiological testing of clinical samples

Appropriate clinical samples (e.g. pus, swab of exudate from abscess or other lesion, sputum etc) from suspected cases should be collected and submitted to the local microbiology department for analysis. It is important that Accident and Emergency (A&E) departments and GPs are alerted to the importance of taking specimens when incising and draining abscesses. Samples should be cultured onto non-selective media (e.g. blood agar) for the recovery of potential pathogens, including *S. aureus*. In cases of suspected necrotising pneumonia it is recommended that co-infection with a respiratory virus, including Influenza A is investigated.

2.2 PVL-testing

MSSA or MRSA recovered from suspected cases should be referred to the Staphylococcus Reference Laboratory at the HPA for toxin gene profiling (this includes PVL-testing). This is a PCR–based assay which is performed on a daily basis and completed within a working day. If cases are urgent results will be telephoned to the submitting laboratory.

Figure 1. PVL-related disease: Microbiology algorithm (3)



* For urgent requests, please contact Staphylococcal Reference Laboratory (tel: 0208 327 7227). Even if PVL testing is performed in a local laboratory it is important that isolates are sent to the Reference Laboratory for further toxin testing and typing. MRSAs with a typical sensitivity pattern for HA-MRSA, and likely to have been acquired in a healthcare setting should not be referred unless the presenting history is suggestive of a PVL infection, e.g. necrotising pneumonia, recurrent boils. This information must be included on the referral forms.

SCREENING SWABS

If screening is undertaken it is essential to include a swab from the anterior nares and any skin lesions which could be infected. Other sites that may be swabbed include throat, axillae and perineum.

2.3 Microbiology testing of screening samples

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

Where the confirmed case is due to *PVL-positive MRSA,* screening swabs should be cultured onto selective media. Suitable selective media include Mannitol Salt Agar (MSA) and chromogenic media. Where MRSA is recovered with an antibiogram which matches that of the confirmed case, isolate(s) should be referred to the Staphylococcus Reference Laboratory.

NB. Currently, the majority of PVL- positive MRSA are susceptible to ciprofloxacin, therefore selective media for the recovery of MRSA which contain ciprofloxacin must be avoided.

2.4 Suspected outbreaks

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

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 (4).

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 is deteriorating clinically.

Incision and drainage is the optimal management for abscesses.

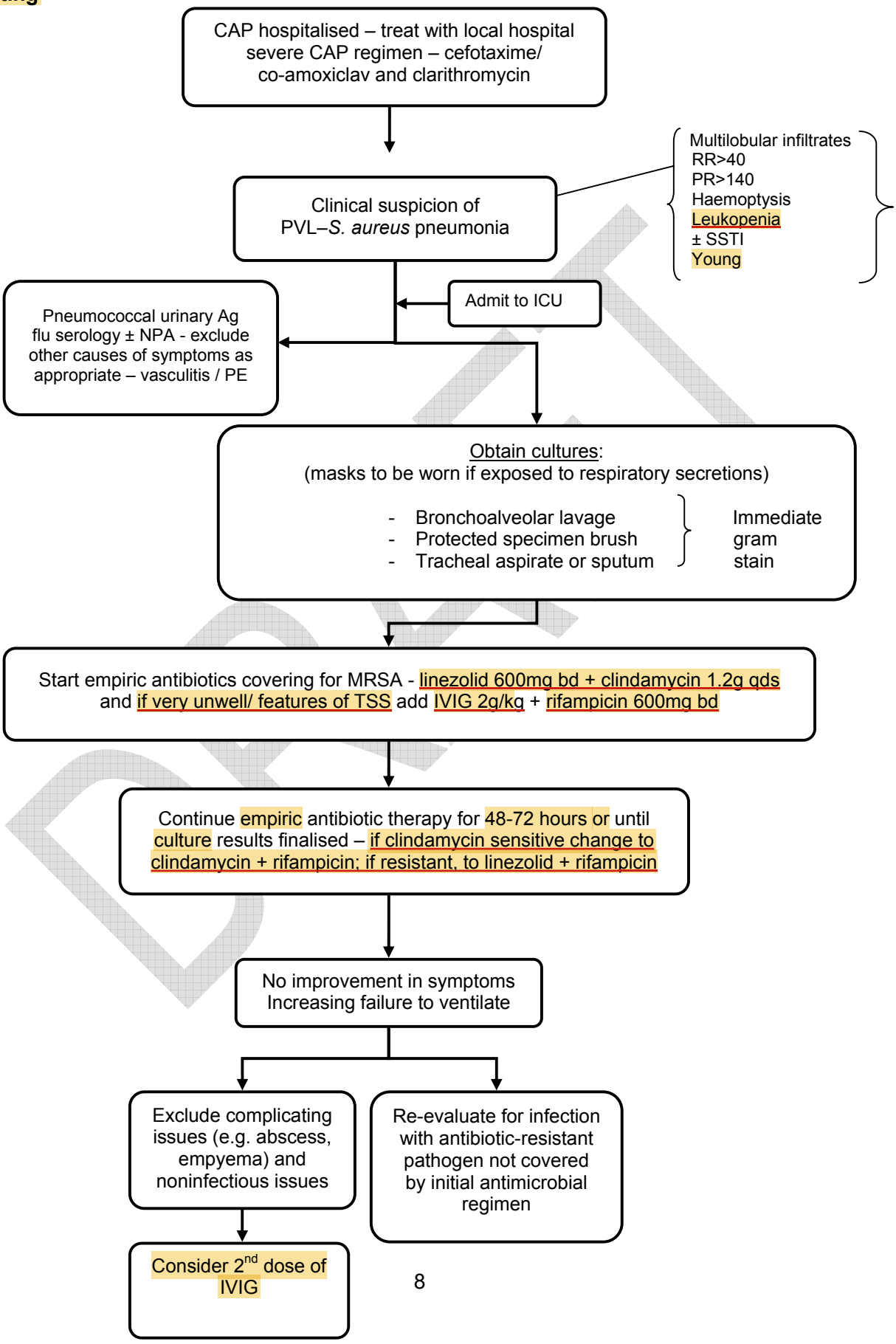
Moderate SSTIs including cellulitis and larger abscesses (especially those greater than 5cm) should be treated with oral anti-staphylococcal antibiotics in addition to appropriate drainage – the choice depends on susceptibility test results.

If there is systemic involvement suggestive of toxic shock or pyomyositis (hypertension, tachycardia, diarrhoea, vomiting, high creatine kinase) empirical parenteral antibiotics effective against MRSA are advised as well as immunoglobulin – see below.

3.1.1 General care

Lesions should be covered, personal hygiene emphasised (including care to 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 an example of a patient information leaflet.

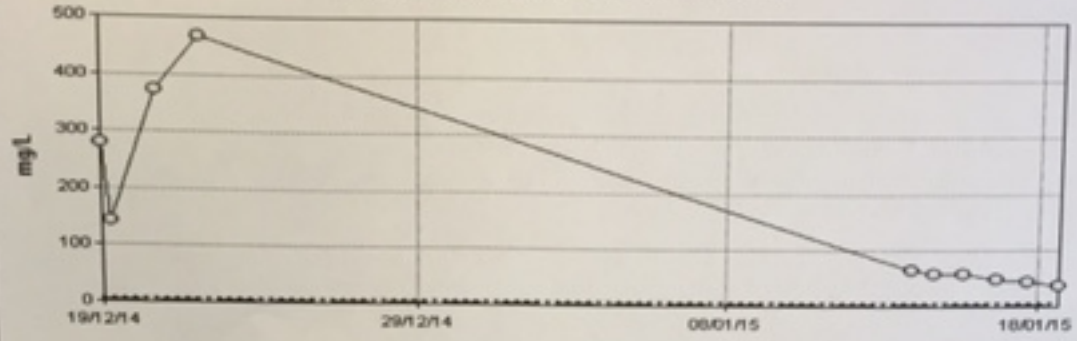
Figure 2. Management of patient with suspected PVL-related pneumonia in the healthcare setting



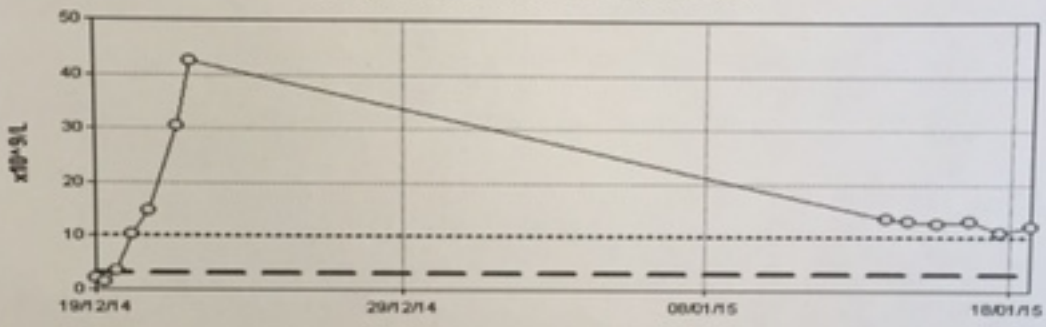
Patient name: G[redacted] K[redacted] Hospital Number: **E01379555** NHS number: **6301624653**

G[redacted] K[redacted]

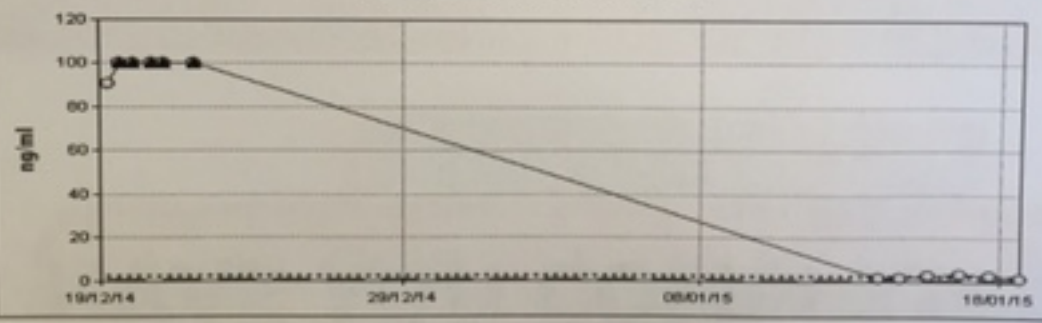
C-REACTIVE PROTEIN - C-Reactive protein



FULL BLOOD COUNT - White Cell Count



PROCALCITONIN - Procalcitonin



3.1.2 When antimicrobials are indicated for SSTI

N.B. Therapy should, wherever possible, be guided by results of antimicrobial susceptibility tests.

Most UK PVL-positive *S aureus* strains are susceptible to flucloxacillin (MSSA) and are usually also sensitive to erythromycin and clindamycin, although tests need to be performed for dissociated resistance to clindamycin in erythromycin resistant strains (see microbiology section).

For moderate SSTI with MSSA, flucloxacillin 500mg qds or clindamycin 450mg qds are recommended.

When PVL-MRSA is suspected, and admission to hospital is not warranted, rifampicin 300 mg bd plus doxycycline (not for children <12y) or fusidic acid 500 mg 8 hourly or trimethoprim 200mg 12 hourly or clindamycin 450mg qds alone can be used. It should be noted that some PVL-MRSA seen currently in the UK are resistant to doxycycline and fusidic acid (A Kearns, personal communication), so it is important that treatment is guided by results of antimicrobial susceptibility tests.

For severe infections where PVL positive staphylococcal infection (MSSA or MRSA) is suspected to be an important pathogen, a variety of antibiotics have been used including parenteral vancomycin, teicoplanin, daptomycin or linezolid. Tigecycline may also offer broader polymicrobial cover if required. There is no evidence that one agent is superior to another.

In severe infections with features of toxic shock or necrotising faciitis or purpura fuminans there may be a theoretical case of using two or three agents such as linezolid 600mg bd combined with clindamycin 1.2 – 1.8g qds and rifampicin 600mg bd. This is based on in-vitro synergy and the ability of linezolid and clinidamycin to switch off toxin production (5). It is very important to undertake early surgical debridement in these infections.

3.2 Community-acquired necrotising pneumonia

Figure 2 shows an algorithm for the management of patients with suspected PVL related pneumonia.

Early clinical diagnosis is difficult but essential for survival. Respiratory symptoms and sepsis in a previously fit young patient following a “flu-like” illness warrants prompt referral to hospital.

Once admitted, the following classical constellation of findings (6) 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)

X-ray

- 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)
- Very high C-reactive protein level (>200g/l: not found in viral infections)
- Negative pneumococcal urinary antigen
- Significantly raised serum creatine kinase (suggests myositis)

NB. a) The CURB65 score (7) may be misleadingly low in young adults on admission due to age being a score factor and b) early in infection the white cell count may be normal as destruction by toxins is just beginning; c) a history of skin lesions may be present in about 25% of cases, but there may be a family history of spreading or recurrent PVL-related skin sepsis (8).

3.2.1 Clinical management (mainly supportive)

- Admit to Intensive Care – preferably in a side room (wear a mask for intubation and tracheal toilet)
- Administer aggressive antimicrobial therapy – see below
- Give intravenous immunoglobulin (IVIG) in a dosage of 2g/kg – see below

NB. Activated Protein C should not be used in case there is active pulmonary haemorrhage.

3.2.2 Antimicrobial therapy

Antimicrobials used in PVL – staphylococcal pneumonia

There are many differing opinions on therapy for PVL-associated pneumonia. Unfortunately, of the many combinations reported, very few reports include the dosages of antimicrobials used. Some report antibiotics not routinely available in the UK. Work is ongoing to find the optimal therapy, and the following are some points from the published literature intended as background information.

It should be remembered that with severely reduced penetration of antibiotics into necrotic tissue and diminished activity in anaerobic conditions, the efficacy of many antibiotics in the treatment of necrotising pneumonia will be decreased.

Intravenous flucloxacillin is not recommended, even when combined with another agent, such as rifampicin or clindamycin. Although bactericidal, there are concerns that at concentrations just above the MIC (as are likely with poor penetration into necrotic tissue) flucloxacillin may increase PVL production in vivo as it does in vitro (9).

There is a suggestion that where an anti-toxin producing agent was included, the outcome was generally more favourable, but with so few cases and so many regimens, there is no proof that any one regimen is unequivocally superior. Combinations of clindamycin with rifampicin (10), linezolid with rifampicin (11, 12) vancomycin with rifampicin (13), vancomycin and clindamycin have all been successful, but with a widely differing duration of intravenous therapy, sometimes as long as 4 weeks (13).

Despite the successful use of co-trimoxazole in PVL- associated SSTI, the subgroup does not recommend its use. The one report of successful therapy in a highly unusual case of chronic PVL-staphylococcal pneumonia of 3 months duration involved 6 weeks of cotrimoxazole following 3 days of intravenous vancomycin (14).

Despite three cases of success with vancomycin as sole initial therapy (15-17), vancomycin should not be used alone because of poor extra cellular fluid levels (18) and penetration of lung tissue (19).

Clinical failures with continuing bacteraemia and isolation from bronchial secretions have necessitated repeated courses of vancomycin (20) or changing to agents such as linezolid and rifampicin (11, 12). It has been suggested that a loading dose of vancomycin 25mg/kg should be given, and thereafter adjusted aiming at a trough level of 15-20 mg/dl serum level to achieve plasma concentration of 3-4 mg/dl (21). Even with a dose of 1.5gm bd and trough levels of 18-35, BAL fluid was not sterilised 7 days into therapy (11).

There are reports of success following "salvage" therapy using linezolid alone or with rifampicin to replace failing vancomycin therapy (11, 12, 22, 23).

Rifampicin has been used in many different antibiotic combinations and has excellent tissue penetration, reaching intracellular staphylococci, and exhibits synergistic activity with other antibiotics, including linezolid (24).

Conclusion:
Taking all the information above into consideration the subgroup recommends empirical combination therapy with clindamycin 1.2 gms intravenously qds, linezolid 500 mg intravenously bd to suppress PVL and alpha toxin production (9, 25, 26), and rifampicin 600 mg bd for intracellular clearance of staphylococci.

Providing the staphylococci are sensitive on testing, this combination of linezolid, clindamycin and rifampicin should be continued until the patient has improved and is clinically stable, when continuation of therapy with linezolid plus rifampicin or clindamycin plus rifampicin may be considered.

3.2.3 Adjunctive therapy with Intravenous Immunoglobulin (IVIG)
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 benefits outweigh the risks in a condition with expected high mortality (>60%). The dosage of 2g/kg of IVIG recommended in streptococcal toxic shock syndrome (27,28) may be applicable for PVL-positive *S. aureus* infections, and may be repeated at 48 hours if there is still evidence of sepsis, or failure to respond.

4. Decolonisation and screening of patients and their close contacts

4.1 Principles of decolonization

Little data exist to determine the effectiveness of topical decolonisation in eradicating and thereby preventing further infections with a particular strain of *S. aureus,* especially in non-healthcare settings and with prolonged follow-up. It is important to note that topical decolonisation is often used to try to interrupt transmission. It can be achieved temporally but re-colonisation can occur in individuals in a relatively short time. With this in mind and whilst awaiting definitive trials on the subject, a common sense approach to screening and topical decolonisation should be adopted. This advice may change as more evidence becomes available.

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

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

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

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

4.2 Decolonisation of cases

Topical decolonisation without prior screening should be offered to primary cases identified according to the algorithm in Figure 1 (see Appendix 2). Recurrent infection is the most common reason for undertaking topical decolonisation.

All patients prescribed topical decolonisation should be given a patient information leaflet describing when and how to use the topical agents and how to minimise cross-infection. The topical decolonisation regimen should be limited to a five-day course. Topical decolonization should be started after the acute infection has resolved.

Patients in whom recurrent infections or persistent colonization occurs despite reasonable efforts to decolonize or because of their underlying conditions, should maintain sensible precautions to prevent transmission in households and community settings, as advised in a patient information leaflet (see Appendix 1).

4.3 Screening and decolonization of contacts

An appraisal of the close contacts (household, family, partner) should be made and whether or not they have already shown signs of possible previous PVL-SA infections. Where close contacts are infected or likely to be colonized because of past infection, topical decolonization for all family members should be performed at the same time as the patient. This may be undertaken without prior screening. If there is no history of infection in family members it may be more appropriate to undertake screening before any treatment. It is essential to include a swab of the anterior nares, but other sites that may be swabbed include throat, perineum and axilla. Until research dictates, the choice of sites it may be simpler to be consistent with local MRSA screening protocols.

Patients and their families should have a heightened awareness of continuing problems of PVL-related disease in the family or close contacts and return to their GP for consultation should this happen. Follow-up screening may be considered at least one week post-decolonisation, and a second round of topical decolonisation prescribed if still positive. This is particularly relevant if there is an individual at high risk of infection or transmission to others.

4.3.1 Decolonisation 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 (29). Close contacts should be offered a five-day topical decolonisation regimen starting immediately (including chlorhexidine gargle if the individual is able to so do). Consideration should be given to using oseltamivir prophylaxis if the index case is found to have had Influenza A by rapid testing.

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

Where there has been one case of PVL-related infection in such homes then enquiries should be made regarding other cases in patients and staff. A risk assessment should be performed looking at the number of cases of PVL disease balanced against the practicalities of screening all staff and residents. Individual cases may be suitable for topical decolonisation. If a significant number of residents and staff are affected, an outbreak meeting should be arranged to discuss infection control issues and feasibility of and practicalities of topical decolonisation. A five-day course of therapy for all residents and staff is a significant undertaking and lack of compliance and patient acceptance are major issues where this has been tried.

4.4.2 Nurseries / schools

Screening of children and staff in a class may be warranted if there are two or more 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 skin lesions. Information about precautions to reduce the spread of PVL-SA is given in Appendix 4.

5. Infection control for hospitalized patients

Hospitals should have policies and procedures for patients and staff, which deal with MRSA and these are generally appropriate for the control of PVL-associated *S. aureus*. For advice about the control of MRSA see BSAC/HIS guidelines, 30). The following section reflects some of the important control measures.

5.1 Community – acquired infections

5.1.1 Skin and soft tissue infections (SSTIs)

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

5.1.2 Necrotising pneumonia

Occasionally, patients will be admitted with necrotising pneumonia. Transmission of PVL-SA has occurred to staff following contact with respiratory secretions during intubation of a case of necrotising pneumonia where PPE was not worn (31). Healthcare workers (HCWs) should wear appropriate PPE, including face and 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 at the time, should be screened three to seven days after the exposure and advised to report to a physician should symptoms of infection present subsequently. All screening should be arranged through the occupational health department in liaison with the infection control team.

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

5.2 Hospital-acquired infections

If a case of PVL-SA infection is recognised as being acquired or possibly acquired in hospital, suitable investigations need to be undertaken. Screening of other patients and staff should be performed based on a risk assessment, and decolonisation of positive individuals undertaken. Frequently, questioning patients and staff for previous individual and family history of recurrent skin infections identifies a potential source.

It is advisable for the microbiology department to search its database for other *S. aureus* infections with a similar antibiogram that may be related and isolates, if still available, sent to the Staphylococcal Reference Laboratory for PVL toxin testing. This will help to ascertain whether there is an unidentified cluster of cases in the hospital.

5.3 Occupational Health

It is necessary for occupational health departments in hospitals to be aware of this guidance.

In line with good infection control practice, HCWs should not work with an infected skin lesion, and all cuts and grazes should be covered.

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

Follow up screens for carriage following post-topical decolonisation 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-colonisation may occur from a close contact. Therefore, even if screened negative, staff should understand that they should stop working if a further skin lesion develops.

If despite two courses of decolonisation 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 providing they cease working as soon as a possibly infected skin lesion develops.

6. Surveillance

The Department of Health is sponsoring two projects which will help 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 SA infection in Bristol and Gloucestershire. In addition, a small study is being undertaken in Devon to identify risk factors for PVL-SA infection. The patient questionnaire being used in this study is provided in Appendix 6.

Surveillance of PVL-SA is based upon the isolates referred to the Staphylococcal Reference Laboratory and shown to be PVL-positive. All PVL-suspected isolates and any PVL-positive strains identified locally should be sent to the Staphylococcal Reference Laboratory. 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.

Appendix 1

PVL *Staphylococcus aureus* Information for Patients

What is PVL Staphylococcus aureus?
Staphylococcus aureus (`Staph') is a type of germ or bacterium that commonly lives on healthy skin. About one third of healthy people carry Staph quite harmlessly, usually on the moist surfaces of the body, such as the nostrils, armpits and groin area. Some Staphs produce a toxin called Panton-Valentine Leukocidin (PVL) and they are known as PVL Staphs.

What type of illness does it cause?
All Staphs, including PVL Staphs, 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 types of Staphs such as PVL Staphs are more likely to cause infections than other Staphs.

How do you catch PVL Staph?
Anyone can get a PVL Staph infection and they frequently occur in fit, healthy people. PVL Staph 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 Staph on it from someone else, for example shared gym equipment, shared razors, shared towels.

How is PVL Staph treated?
Infections are treated with a course of antibiotics. In addition, the PVL Staphs carried on your skin are eliminated with a five day skin treatment (DN with creams and shampoos). This is done to reduce the chances that you get repeated infections and also to reduce the chances that you spread PVL Staphs to others. In some patients this skin treatment may not be entirely successful, but the more carefully you adhere to the instructions for the five day treatment, the more likely you are to clear the PVL Staphs from your skin. Your GP may recommend checking members of your household and close contacts, e.g. partner, in case they are also carrying PVL Staphs, and offering them skin treatments where necessary.

How do I prevent passing PVL Staphs 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 Staphs that can spread to others.
- Do not touch, poke or squeeze infected skin. This contaminates your hands and can push the PVL Staphs 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 Staphs can live in your nose. Throw the tissue in the bin straight away and wash your hands.
- Wash your hands frequently with liquid soap and water, and **in particular** after changing your plasters, dressings, and bandages or touching infected skin.
- Encourage others in your house to wash their hands regularly with liquid soap.
- Use a separate towel and keep it separate, so others don't use it by mistake.
- Regularly vacuum and dust (wiping with a damp cloth) your bedroom, bathroom, kitchen and other rooms, as well as personal items. Household detergent is adequate for cleaning.

- Clean your sink, taps and bath after use with a disposable cloth and household detergent, and then rinse clean.
- 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.

Can I go to work or school when I have a PVL Staph infection?

- You should not work as a carer in a nursery, hospital, residential or care home or similar place of work 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 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 if you should work, contact your local occupational health department or your GP.
- Children can go to school, only 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.
- 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 PLV Staph infection. You need to continue treating your skin to keep it in good condition in the long term helps to reduce the risk of spread of PVL Staph to others.

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, do not use communal towels. When you go to shared facilities, which should be used only when skin lesions have healed put a towel between your skin and the equipment. Importantly, shower afterwards and use a separate (second), clean towel to dry yourself. Wash the 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 Staph persistently on your skin or nose, or if you suffer from repeated infections, you will be prescribed a further course of skin treatment. If this fails to eliminate the PVL Staph and you suffer repeated infections then you may be prescribed antibiotics and skin treatment together. 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 Staph infection previously. This ensures you are looked after appropriately.

Appendix 2

Decolonisation procedure for PVL-*Staphylococcus aureus*

How to use the skin decolonisation preparations Chlorhexidine (4%) or Triclosan (2%) for skin decolonisation and Mupirocin (Bactroban Nasal) for nasal decolonisation.

The purpose of this treatment is to try to rid the body of the germ (bacteria) that has caused boils or other infections. In order for the treatment to be effective, however, it is important that the preparations are used according to the following instructions.

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
- Avoid bar soap and use pump action liquid soap instead
- Use individual personal towels
- Clean sink and bath with a disposable cloth and detergent, and then rinse clean

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

- Use daily as liquid soap in the bath, shower or bowl and as a shampoo on day 1, day 3 and day 5
- Do **NOT** dilute it beforehand in water as this will reduce its efficacy – apply direct 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 before drying thoroughly
- Towels should be for individual person use and changed daily

It is important to ensure that the product is rinsed off the skin and skin is dried properly, especially for people with skin conditions.

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

- Apply a pea-sized amount (less for a small child) on the end of a cotton bud to the inner surface of each nostril and massage gently upwards.

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

Appendix 3

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

What is PVL-*Staphylococcus aureus?*

Staphylococcus aureus (`Staph') is a germ or bacteria commonly found living on healthy skin. It particularly likes moist surfaces of the body, such as the nostrils, armpits and groin area. People carry many different strains of Staph, and some types cause more infections than others. Ones that produce Panton-Valentine Leukocidin (PVL) toxin commonly cause boils or skin abscesses and are occasionally associated with more serious infections of the lungs, blood, joints and bones. Some community strains of MRSA (meticillin resistant *Staphylococcus aureus*) can also produce PVL toxin.

1. Standard precautions including handwashing and general hygiene

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 in place 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 and treatment or decolonisation has begun.

- The premises should ensure that access to basic handwashing facilities are 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 (32).
- 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 where hands may be visibly soiled;
- 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 decolonisation has begun;
- Personal items (e.g. towels, robes etc) should not be shared unless after each laundry episode;
- Soap, razors and toothbrushes should not be shared at all;
- Use a barrier (e.g. a towel or a layer of clothing) between the skin and shared equipment;
- Shower if there has been substantial skin-on-skin contact with another person.

2. Shared equipment (e.g. exercise machines)

While using shared equipment on the premises, patrons 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 before and after use, especially if the surface has become wet with sweat; and
- Assist staff with the disinfection of frequency touched equipment surfaces if spray bottles of disinfectant are made available and instructions for use are provided.

Staff should be encouraged to:

- Provide hard surface detergent wipes, to be used by patrons before and after the use of equipment;
- Clean shared equipment surfaces daily;

- Disinfect shared equipment surfaces daily with a detergent disinfectant according to manufacturer's instructions;
- Check with equipment manufacturers for recommendations on the appropriate maintenance of their products;
- Repair or dispose of equipment and furniture with damaged surfaces that cannot be adequately cleaned;
- The premises should ensure that there is a policy for environmental cleaning and an additional contingency plan for outbreaks of infection;
- The managers of the premises should ensure staff receive appropriate training for general cleaning purpose;
- The management of the premises should ensure that they have access to good standard detergent for cleaning.

3. Steam rooms, saunas and pools

While using these facilities, patrons 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:

- Allow steam rooms/saunas to dry at least once a day (this will help to minimize the development of a bacterial biofilm);
- Clean and disinfect frequently used surfaces at least daily;
- Consider painting wood benches with a water-proof paint or varnish to seal and smooth the surface, facilitate drying, and reduce areas where bacteria may grow;
- Ensure a halide, residual (e.g. chlorine) recommended for swimming pools, spa pools and other basins or tanks used for immersion by multiple patrons;
- Fill spa pools used for single-use immersion (e.g. tanks or pools that are drained after each use), with a 500-615 ppm concentration of bleach [33].

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. Items which can only be washed at lower temperatures should be washed separately.
- Use laundry detergents according to the manufacturer's instructions.
- Use a mechanical dryer on hot temperature cycle (i.e. avoid air drying); and
- Distribute towels, uniforms, etc. only when they are completely dry.
- Wash hands after handling dirty laundry.

5. Use of disinfectants on surfaces

(General Considerations)

- 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 thoroughly after cleaning;
- Unused working solutions of disinfectant 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 it is recommended that it is rinsed thoroughly afterwards.

Disinfectant Strategies for Steam Bath and Sauna Surfaces

- For nonporous surfaces (e.g. tile, stainless steel, epoxy, and linoleum) use an EPA-registered detergent disinfectant suitable for the type of surface being treated. If an EPA-registered product is not available, a dilution of household chlorine bleach can be used for nonporous surfaces according to manufacturers instructions.
- For wood surfaces, scrub and disinfect with a dilution of household chlorine bleach according to manufacturers 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 restarting the heat to prevent irritation of the eyes and breathing difficulties.

Appendix 4

The following measures may help prevent the spread of PVL-*Staphylococcus aureus* infections in schools and nurseries

1. Hand hygiene should be facilitated by providing adequate washing facilities and supplies. Liquid soap dispensers (not soap bars) should be used and paper towels 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 wound is no longer draining (see below).

5. Contaminated surfaces should be cleaned promptly using 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.

For individual cases with PVL-*Staphylococcus aureus* 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 which will stay dry and in place until the end of the school day.

2. Individuals should not be at school if they have a fluctuant boil that requires drainage or a newly discharging boil or abscess, the leakage from which cannot easily be contained.

3. Individuals must have been given a patient information sheet outlining precautions they should take to minimise the chance of infecting others.

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 for the eczema or skin condition has been optimised and a course of decolonisation has been completed. Treating the skin condition is of paramount importance if decolonisation is to be successful. Maintaining optimal treatment for the skin condition in the long term is essential in reducing the risk of spread of PVL-*S. aureus* to others.

Appendix 5

Advice to managers of care homes to help reduce transmission of PVL-*Staphylococcus aureus*

Standard Infection Control Precaution
All personnel involved in providing care should be trained in Standard Principles for Infection Control. This is divided into 3 broad categories:

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

In any environment that delivers care, ensuring that staff are trained in the Standard Principles for Infection Control is essential. In an environment where one (or more) individual has a confirmed or suspected PVL lesion this must be re-enforced to reduce the potential for further spread and outbreak among other residents and staff.

Hand hygiene is the single most important activity to assist in reducing the transmission of micro-organisms from one area of the body to another and subsequently to other residents and staff. It is essential that the establishment 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 or secretions. Hands must be washed when visibly soiled.

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

Aprons are a single use item and should be worn for all direct patient care which includes bed making, cleaning equipment following use, and when there is a risk of contamination to clothing during the procedure. Aprons must be used for one procedure or activity and disposed of as clinical waste at the end of the procedure and hands washed.

Gloves are not a substitute for hand washing and like aprons should be used for one activity and then be disposed of as clinical waste and hands must be washed. The individual staff member should ensure that they have risk assessed the activity and have good fitting appropriate gloves for the activity.

Environment and General Cleaning
All care facilities should be cleaned to the highest possible standard as the residents who live here have the right to this basic requirement.

A clear and specific plan should be set to identify the cleaning service and the roles and responsibilities of those involved. This should incorporate such instances when there is an outbreak or significant risk of infection. This plan should also clearly identify the strategy implemented for terminal cleaning which may include the employment of outside contractors.

It is essential that those individuals employed to provide an environmental cleaning service have had training and education to affect the best possible outcome. Again this is the individual's responsibility to take up this training but the responsibility of the home manager and the registered owner to make this available.

Laundry Facilities

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

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

PPE should be made available for staff employed to undertake the laundry service. In addition 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 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 then 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 (34).

Appendix 6

PVL Staphylococcal Infection
Patient Questionnaire

We would be grateful for your help in completing this questionnaire. The information will assist us in giving you the advice you need and help us to learn more about PVL staphylococcal infection. Your details will be kept confidential to members of the Health Protection Team.

1. **Patient details**

a. Name **b**. Sex **male / female**

c. Date of birth ../ ../ .. dd/mm/yy **d.** Age (years)

e. Address

..postcode

f. GP name
GP practice

g. 0ccupation/school/university/college/nursery

h. Do you work as a carer (e.g. in child minding, nursery school, playgroup, care home, social care, independent care agency, go into care home as part of your work, healthcare worker in hospital or in a prison) ? **Yes / No**

If **yes**, please give details of workplaces in last 12 months and approximate dates:

Work place	Approximate dates

2. Current / recent infection.

a. Have you recently had or you are you currently suffering from an infection. An infection refers to unusually painful spots, sore areas such as boils, abscess, pre-existing skin conditions that become more uncomfortable such as eczema or psoriasis, or any other infections identified by your doctor such as joint infections or pneumonia.

Yes/No **If No, go to Q3**

b. If **yes**, please complete the following:

Site of infection:

		If **Yes** please give details
Skin / soft tissue	**Yes / No**	
bone / joint	**Yes / No**	
internal abscess	**Yes / No**	
lung (pneumonia)	**Yes / No**	
Other	**Yes / No**	

Have you been in hospital because of this infection? **Yes / No**

If **yes**, did you have an operation e.g.: drainage of boil / abscess? **Yes / No**

If **yes** please give details? . .

Did you receive antibiotics? **Yes / No**

If **yes**, what antibiotics were used? . .

3. Past infections

a. Have you had a similar infection in the past? **Yes / No**

If **yes**, please give approximate dates (month, year) and brief details

b. Have any members of your household had boils or skin infections in the past year? **Yes / No**

If **yes**, please give details:

Name of household member	Relationship to you	Date of birth	Approximate date(s) of infection(s) month/year

4. Contacts

a. Do you have nursery or school age children? **Yes / No**

If **yes**, what school(s), nursery(ies) do they attend?

b. Are you aware of any other people in your workplace with an infection similar to yours? **Yes / No**

If **yes**, please give details:

5. Leisure

a. Do you use a gym/sauna/spa pool? **Yes / No**

If **yes**, please complete the following:

Name of Gym/Sauna/Spa pool .
Address

How often do you attend? .. .

When did you last attend before your infection? ...
..

b. Do you play any contact sports e.g.: football, rugby, judo, karate, rowing? **Yes / No**

If **yes**, please give details

c. Do you share bathing facilities outside the home e.g. rugby club baths, sauna, showers? **Yes / No**

If **yes**, please give details

6. Pets

a. Do you have contact with animals, including pets? **Yes / No**

If **yes**, please give details

b. Are they fit and well? **Yes / No**

If **no**, please give details

Thank you for completing this questionnaire.
Please return it in the enclosed SAE to:

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Membership of the subgroup

The subgroup was convened by the Steering Group on Healthcare Associated Infection in December 2006 and comprised of the following members:

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Dr Jane Steer	Consultant Microbiologist, Plymouth Hospitals NHS Trust

Glossary

CA-MRSA Community associated meticillin resistant *Staphylococcus aureus*

HA-MRSA Hospital associated meticillin resistant *Staphylococcus aureus*

MRSA Meticillin resistant *Staphylococcus aureus*

MSSA Meticillin sensitive *Staphylococcus aureus*

PVL Panton-Valentine Leukocidin