



Skin Prick Testing Guide for Diagnosis of Allergic Disease

This Guide is intended for medical practitioners and nurses in Australia and New Zealand, and outlines the application, method and interpretation of allergy skin prick tests. This document was updated in 2020 by the ASCIA Allergen Immunotherapy and Skin Testing Working Party. Members are listed on the ASCIA website www.allergy.org.au/members/committees#wpim

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ABBREVIATIONS

AR	Adverse reactions	RCPA	Royal College of Pathologists of Australasia
AIT	Allergen immunotherapy	RSV	Respiratory syncytial virus
IgE	Immunoglobulin E	SAS	Special Access Scheme
IDT	Intradermal test	SPT	Skin prick test
OTC	Over the counter	SR	Systemic reactions
PBS	Pharmaceutical Benefits Scheme	TGA	Therapeutic Goods Administration
RACP	Royal Australasian College of Physicians		

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1. INTRODUCTION

There are three types of skin testing used in allergy diagnosis:

- **Skin prick testing (SPT)** is the primary mode of skin testing for immediate IgE-mediated allergy. It is widely practiced, carries very low risk of serious side effects, and provides high quality information when performed optimally and interpreted correctly. It is also called prick skin testing or PST.
- **Intradermal testing (IDT)** is relevant to both immediate IgE-mediated allergy and delayed-type hypersensitivity. When used in the diagnosis of immediate allergy, it carries a higher risk of adverse reactions and requires high levels of technical and interpretive expertise.
- **Patch testing** is relevant to contact hypersensitivity and some other forms of delayed-type hypersensitivity. It is conducted mainly by dermatologists and some immunologists. It is not relevant to immediate or IgE-mediated allergy, thus it will not be further discussed.

Scratch testing is not endorsed and should not be performed.

SPT provides information about the presence of specific IgE to protein and peptide antigens (allergens).

Small amounts of allergen are introduced into the epidermis and non-vascular superficial dermis, and interact with specific IgE bound to cutaneous mast cells. Histamine and other mediators are released, leading to a visible wheal-and-flare reaction peaking after about 15 minutes.

The value of this test depends on many steps, including:

- The relevance of the test allergen to the condition under investigation.
- The correct introduction of a sufficient amount of allergen in its native (allergenic) form.
- The functional status of cutaneous mast cells.
- The interpretation of the reaction in the context of positive and negative controls.

SPT has good sensitivity and specificity for the presence of allergen-specific IgE, and in some cases is more sensitive than *in-vitro* testing for specific IgE in serum (Wood, Phipatanakul, Hamilton, Eggleston, 1999; van der Zee, de Groot, van Swieten, Jansen, & Aalberse, 1988). The discomfort is small and the risk of systemic reactions is minimal although not negligible.

The integration of SPT results, knowledge of the biology of the various allergens and the exposure of the patient, and the nature and timing of the symptoms enable the construction of a diagnosis, and an appropriate management plan for the patient.

IDT has more specialised applications such as testing for IgE-mediated drug allergy, particularly penicillin, and venom allergy. It carries a higher risk of anaphylaxis and is generally restricted to a hospital or specialist setting.

2. PRE-TEST CONSIDERATIONS

Indications for allergy SPT	SPT not routinely indicated in the investigation
Rhinitis/rhinoconjunctivitis/rhinosinusitis/allergic conjunctivitis.	Nonspecific rash without allergic/atopic characteristics.
Asthma	Chronic urticaria in the absence of allergic features on history.
Atopic dermatitis	Food intolerance without allergic features (e.g. irritable bowel syndrome).
Food reactions such as those manifested by anaphylaxis, immediate acute urticaria, or acute flare of eczema.	Assessment of the effectiveness of allergen immunotherapy.
Suspected latex allergy.	Chronic fatigue without allergic features.
Conditions in which specific IgE is considered likely to play a pathogenic role (e.g. selected cases of chronic urticaria if the history suggests an exogenous allergic cause).	Migraine headaches/behavioural disorders.
Rarer disorders such as allergic bronchopulmonary aspergillosis, eosinophilic oesophagitis or eosinophilic gastroenteritis.	Reactions to respiratory irritants (smoke, fumes, perfumes etc.).
Rhinitis/rhinoconjunctivitis/rhinosinusitis/allergic conjunctivitis.	Screening for allergy in the absence of symptoms (e.g. family history of allergy).

SPT is not usually appropriate for the diagnosis of reactivity to low molecular weight substances such as food additives, non-allergic AR to medications (with some exceptions), respiratory irritants, and most occupational allergens (with some exceptions).

Conditions for which IDT is appropriate

IDT may be used in the diagnosis of:

- Insect venom hypersensitivity.
- Immediate allergy to beta-lactam medications, and other medications where validated protocols exist.
- Immediate hypersensitivity to some vaccines.

IDT is recommended for hospital or specialist use only. IDT is not indicated for aeroallergens, and is contraindicated in routine practice for food allergy.

Allergy testing has been shown to increase the accuracy of diagnosis when added to history and clinical examination (Carter, Pulos, Delaney, Matheson, & Moffitt, 2000). It differentiates allergic diseases from other mimicking conditions. It may lead to allergen avoidance strategies, improved use of medications, and for some patients, desensitisation treatment (allergen immunotherapy). The strongest indications for SPT are where there is good evidence for the effectiveness of allergen avoidance or allergen immunotherapy.

Conditions for which SPT is appropriate

SPT are also frequently used for epidemiological purposes or to define atopy in an individual without specific disease diagnosis considerations. A definition of atopy is “the genetically determined tendency to produce specific IgE to common environmental allergens”. A positive reaction to one or more of a panel of the most prevalent allergens to which the subject or population is likely to be exposed to defines the subject as atopic. A lack of atopy, by this definition, does not exclude the possibility of sensitisation to other allergens that were not tested. Certain allergies are not directly related to atopy (e.g. insect venom or medications).

PATIENT SELECTION IN SPT

Patient age

There are no strict age limits, but skin reactions are often diminished in the very young and the elderly, making interpretation difficult in both cases. Infants often show larger flares and smaller wheals. Systemic allergic reactions may occur rarely in response to skin testing in infants (as in patients of any age). Because of increased risk and greater complexity of interpretation, SPT below the age of two years of age is a specialist practice.

Contraindications and precautions

Contraindications for SPT	Relative contraindications and precautions for SPT tests - must be done in specialist practice
Diffuse dermatological conditions as the test must be performed on normal healthy skin.	Persistent severe or unstable asthma.
Severe dermatographism.	Pregnancy because of the small risk of anaphylaxis with hypotension and uterine contractions.
Poor subject cooperation.	Babies and infants.
Subject unable to cease antihistamines or other interfering medications.	Patient on beta-blockers.

Medications that interfere with the SPT response

A large range of medications may reduce skin reactivity and must be withheld before skin testing (see Appendix B).

Medications that may be contraindicated in SPT

Beta-blockers are contraindicated in situations in which the risk of systemic anaphylaxis is increased (see “risks of skin testing”). ACE inhibitors may be relatively contraindicated in the same circumstances. These medications may interfere with the normal compensatory mechanisms in anaphylaxis, and beta-blockers interfere with the effect of adrenaline. In general the risk of systemic anaphylaxis from SPT is low and the medications need not be withheld except where certain high-risk features exist (see “risks of skin testing”).

Patient factors leading to variability in skin test results

Dermatographism can cause nonspecific wheal-and-flare results to skin pricking alone; the negative control may show a wheal and this renders the allergens difficult to interpret unless the reaction is markedly larger than the negative control. Mild dermatographism does not preclude skin testing. Some techniques of SPT may be more likely to activate dermatographism.

The following factors may lead to some variability but this is not usually significant in result interpretation; menstrual phase, race, circadian rhythm, seasonal variation, and atopic dermatitis found elsewhere on the body.

The following conditions can reduce skin test reactivity; chronic renal failure, cerebrovascular accident (CVA), cancer, spinal cord injury, diabetic neuropathy, recent anaphylaxis, and advanced chronological age. SPT should not be carried out on limbs affected by lymphoedema, paralysis or neurogenic abnormalities.

One study demonstrated that individuals infected with respiratory syncytial virus (RSV) show increased histamine wheal size and false positive allergen skin test wheals. This study suggested the possibility that skin tests carried out in the presence of acute viral infection may need to be interpreted with caution (Skoner, Gentile, Angelini, & Doyle, 2006).

Other tests for specific IgE

Serum specific IgE

Serum allergen specific IgE testing is an automated test performed on blood samples by a pathology laboratory. As the name suggests it detects free antigen-specific IgE in serum as opposed to antigen-specific IgE bound to mast cells in the skin.

Whilst the results of SPT and serum specific IgE tests are usually concordant, there are some exceptions to this and in the past it was considered that the SPT is more sensitive. Newer methods may have improved the sensitivity of serum testing compared to SPT. However, in some cases this remains limited (e.g. latex testing).

The sensitivity and specificity of both tests depend on the cut-off of the serum IgE level or the skin test wheal size.

The table below is not intended as a detailed review of the comparative diagnostic utility of both of these tests but a comparison of the main features of skin prick testing and serum specific IgE testing.

Serum specific IgE test	Skin prick test
Advantages of <u>serum specific IgE</u> testing versus skin prick testing	
Widely available in any medical setting.	Available only where equipment, reagents and trained staff are on hand.
Minor pain, venesection.	Minor discomfort, itching.
Little patient effort or cooperation required.	Requires patient cooperation.
No risk to patient; may be first line with certain high-risk allergens.	Slight risk of systemic allergic reaction, more so in some situations.
Can be done where there is extensive skin disease.	Requires areas of normal skin for testing.
Can be done where the patient has taken antihistamines or is unable to stop certain medications which might interfere with SPT.	Must stop antihistamines and some antidepressants and other medications several days before test (see appendix 2).
Many allergens available, including some which are not available for SPT or not routinely carried in SPT settings. Some laboratories may send away samples for rarer allergens.	Many allergens available, but some low-demand allergens will not be carried by individual practices.
Laboratory test, subject to quality control and standardization.	Methodology and result quality variable, no standardisation or formal quality control.
Advantages of <u>skin prick testing</u> versus serum specific IgE testing	
Venesection may be painful or anxiety-provoking particularly in children.	Minor scratch, itch if positive.
Results may take days or weeks.	Results in half an hour.
Results are not directly meaningful to patients.	Results are visible and compelling to patients; may have value in ensuring compliance with allergen avoidance measures.
Reasonably good sensitivity.	In most cases, shown to have better sensitivity for clinically valid allergies.
Some food allergens, medications, rarer pollens not available for testing.	Can extemporaneously prepare allergens (with appropriate considerations; specialist practice).
Some allergens particularly foods may show low sensitivity in certain clinical situations.	Freshly prepared food allergens may show more sensitivity in certain circumstances (caution- risk of anaphylaxis).
False positives possible with high total IgE levels.	No interference from high total IgE.
Numerical results obtained on different types of equipment are not directly comparable.	Numerical measurements may vary by different operators.

Both serum allergen specific IgE tests and SPT require skill and knowledge for the interpretation of results and application to the clinical problem of the patient.

Intradermal skin testing

Allergens are injected intradermally to produce a small bleb, and the outcome measure is an increase in the size of the wheal at 20 minutes. Allergens need to be diluted (100 - 1,000 fold) from the concentrations used for SPT. Skill is required to inject correctly and interpret the result. Most importantly, there is a small but significant (much higher than SPT), risk of systemic reactions including anaphylaxis. A number of deaths have been reported from IDT, but only one from SPT (Bernstein, Wanner, Borish, & Liss, 2004).

IDT is considered a specialist practice and is generally performed in a hospital (or equivalent specialist) setting. IDT is usually contraindicated for food allergy and is considered inappropriate for the majority of cases of suspected inhalant allergy because of lack of specificity (Wood, Phipatanakul, Hamilton, & Eggleston, 1999; Nelson, Oppenheimer, & Buchmeier, 1996; Schwindt, Hutcheson, Leu, & Dykewicz, 2005). SPT has been shown to correlate better with symptoms than IDT (Idrajana, Spieksma, & Vorrhors, 1971; Dreborg 1989).

IDT has an established place in testing for penicillin allergy and may be appropriate for cephalosporin allergy, although validated protocols are lacking. IDT is used for diagnosis of allergy to many medications such as insulin, opiates, anaesthetic agents, muscle relaxants, and enzymes. It can be used for bee venom allergy testing although the clinical predictive value of the test is open to question (Golden et al., 2001).

Regulatory issues

Many products used in SPT are not registered in Australia and not freely available for medical practitioners to purchase. Supply of reagents is subject to provisions of the TGA. For information on registered products and suppliers see the ASCIA website www.allergy.org.au/members/ascia-member-access-to-spt-reagents

Personnel carrying out the test

Certain restrictions apply if the patient is intending to claim a rebate from Medicare for the performance of an allergy test. Items from the Medicare Benefits Schedule are available at www.allergy.org.au/members/ascia-member-access-to-spt-reagents

Consent

In most practices, patient informed consent has not routinely been sought for SPT. If unregistered commercial histamine or unregistered allergen extracts [under section 19(1) or 19(5)] are used, informed patient consent is mandatory according to TGA regulations. The basis for this consent is not an increase in risk from the use of these products, but rather a notification to the patient that “the product is not approved in Australia by the TGA and therefore that the Commonwealth can give no guarantee as to its safety, quality or efficacy and accordingly the Commonwealth can accept no liability for its use”.

3. METHODS

Allergens for SPT

Commercial extracts

Allergen extracts are manufactured specifically for the purpose of SPT. These are aqueous solutions of proteins extracted from the relevant materials, combined with 50% glycerol which acts as a preservative. The solutions are therefore quite viscous. They are supplied in multi-use dropper bottles.

Skin testing reagents must be registered by the TGA before they can be distributed in Australia.

Composition of skin testing extracts

Allergy extracts should contain all allergenically relevant proteins of the labeled substance, and should be free of cross-contamination with allergenic proteins of other substances (e.g. an allergen extract of one type of plant pollen should not be contaminated with another pollen). Some extracts contain defined mixtures of related allergenic substances (e.g. a mixture of weed pollens or related tree pollens, or several species of alternaria mould). Some extracts are standardised for allergenic potency, whereas others are prepared according to weight of allergenic material used for elution of allergens.

Allergen extracts are complex mixtures and contain a range of allergenic proteins which can be separated by electrophoresis and visualised by immunoblotting. Different manufacturer's preparations (and different batches from the same manufacturer) of the same allergen may vary in their content and proportion of the major allergenic proteins. This might be due to differences in the source material or its preparation (e.g. fungal species from different sources, cultured under different conditions and harvested at different stages of life cycle), and the techniques of allergen preparation (e.g. the use of pyridine in extraction of dust mite allergens reduces the proportion of Der P1).

Although only one range of extracts is predominantly used in Australia, these differences may explain variability of results, unexpected positive or negative results, and some differences between SPT and serum specific IgE tests. Interpretation of published studies must take into account the possibility of results being affected by the source of extract. Standardisation of extracts is a major issue to which attention is being directed by allergy authorities and manufacturers.

Allergenic substances invariably contain hundreds of different proteins, each with a unique sequence; only a subset of these proteins is potentially allergenic. However, different individuals form IgE to different proteins within this mixture. If the particular protein(s) to which IgE is directed in a particular individual is not represented within the allergen extract (due to manufacturing processes or protein lability), this may lead to a negative allergy test, even though the individual is allergic to the substance when encountered in nature. This is a potential cause for false negative SPT.

Cross reactivity

Cross-reactivity is an important concept in choice of extracts for skin testing and interpretation of results. Cross-reactivity describes the phenomenon whereby IgE reactive to a particular allergen also reacts to other similar allergens; the patient may never have been exposed to the second allergen. Cross-reactivity of pollen and other allergens often relates to phylogeny but there are sometimes patterns of cross-reactivity that would not have been predicted by biological relatedness, due to proteins that have conserved structures across diverse species. Where two allergens are fully cross-reactive it may not be necessary to include both in testing panels if economy is important. For example many grass pollens are fully cross-reactive with rye grass, so it may not be necessary to test separately for orchard grass etc. On the other hand there are reports that timothy grass, which is in the same family as rye grass, is usually cross-reactive but has some unique allergenic proteins, so in areas where it is prevalent it should be included in the panel.

Allergen test panels

The allergens that are tested for should be relevant to the patient's clinical condition and exposure. In general the smallest number of allergens required to establish a diagnosis and adequately manage the patient should be used. Relatively small allergen panels (e.g. eight to twelve inhalant allergens) would usually be considered

adequate for testing by general practitioners or respiratory laboratories. For allergy specialists, more detailed information may be required, particularly when planning AIT, and to identify less common allergies. Panels should also vary with the locality depending on differences in flora and fauna. However, practice varies widely and panels of between six and 60 allergens for one test are advocated by different authorities. If a practice does not perform large numbers of tests it is usually not economical to maintain a large panel.

Food allergens

Testing for IgE-mediated food allergy by SPT is valid but interpretation is complex. Positive tests often occur without clinical allergy and negative tests in the presence of clinical reactivity may occur, for many reasons. There is a greater risk of anaphylaxis during SPT to foods than with aeroallergens, and IDT is almost never appropriate for foods. Commercial allergen extracts are available but are non-standardised. In some cases it is more effective to carry out SPT using freshly prepared food extracts or the food itself. Food allergy testing is not appropriate for non-specialist practices, general practitioners and respiratory laboratories because of risks, carrying and managing reagents, and complexity of interpretation of results and counseling of patients.

Alternative sources of skin testing reagents

Fresh foods can be used for skin testing, but the procedure and interpretation are specialised, and risk of anaphylaxis is increased. There may be variability in the allergenic quality of the food or its relevance for testing.

Pollen extracts may theoretically be prepared but this is difficult and best left to experienced practitioners. Pollen collection must be optimal as should extraction of allergens into solution. Most of the allergenically relevant pollens (or closely related, cross-reactive species) are available as commercial extracts.

Other sources of skin testing reagents include other commercial companies and laboratory-prepared protein extracts, generally for research applications. When any sources of allergen other than the standard commercially available ones are used it is strongly recommended that this be recorded on the report form.

Maintenance of allergen extracts

Allergen extract bottles should be clearly labeled. They are usually supplied as a dropper bottle with a rubber teat and glass dropper. They should be stored in a temperature-monitored refrigerator and left out for as short a time as necessary to conduct the test. The expiry dates should be checked since the potency of the extracts may vary with time. Potency and longevity are also compromised by dilution and high temperatures. Precautions must be used to prevent bacterial contamination and cross-contamination between allergens.

The following practical measures are recommended:

- Label the test solution bottles with numbers and place them in order in a rack.
- Only open one bottle at a time. If a stopper is put onto the wrong bottle, this results in contamination with the other allergen, and bottle and stopper must be discarded.
- Clean the patient's skin prior to testing to prevent contamination of the tip of the dropper. Only use on intact skin.
- When depositing the allergen solution drop on the patient's skin. It is acceptable to touch the drop against the skin, but not the glass tip of the dropper.

Inappropriate allergens

Allergens acting through IgE or type-1 mechanisms can be appropriately tested by SPT. However, airborne substances may produce allergy-like symptoms through other mechanisms such as respiratory irritation. For example, it is not appropriate to test for cigarette smoke or tobacco by SPT. Plants may be strongly scented or produce volatile irritant compounds which can cause allergy-like symptoms, yet this is distinct from allergy to plant pollen. Patients may complain of symptoms from jasmine vine or roses, yet this is not due to pollen allergy, and SPT is not an appropriate investigation. Pollens from many flowers are entomophilous (designed to be spread by insects), therefore they are sticky and heavy, and not likely to be inhaled.

Foods often produce symptoms through non-IgE mechanisms, for example, negative SPT for wheat does not exclude coeliac disease, and negative testing for milk does not exclude lactose intolerance, or delayed immune reactions to dairy products. If these disorders are suspected SPT is not the appropriate investigation.

Positive and negative controls

Positive and negative controls are essential for the following reasons:

- Some patients display dermatographism or develop a small flare or wheal from the pinprick alone. This leads to an apparent reaction to extracts to which the patient is not sensitised. The negative control would be expected to show a similar reaction. If this occurs then either the test must be rejected as uninterpretable (if there is insufficient distinction between the reaction to the negative control and the positive control), or interpreted by comparison with reaction to the negative control (e.g. if the negative control produces a wheal of 3mm, only wheals of >6mm will be considered positive). Caution is required since the dermatographic response is often inconsistent at different skin sites, and may produce different reactions for a range of extracts to which the patient is not allergic. Wheals of >3mm to the negative control indicate severe dermatographism and would require rejection of the test. Careful technique can minimise nonspecific reaction in dermatographic patients.
- The positive control should produce a wheal of approximately 6mm, and if there is no wheal or only a tiny one, this may indicate either that the patient has taken an antihistamine or a drug with antihistamine activity (see Appendix B), or that they have non-reactive skin, in which case SPT will not be possible. It is recommended that a wheal of ≥ 3 mm to the positive control is acceptable (or 3mm greater than the negative control), and if it is <3mm the test should be considered uninterpretable.

The negative control is the same solution as the allergens are made up in (e.g. saline buffer/50% glycerol), without any allergen.

The positive control can be a solution of histamine (usually histamine phosphate 10mg/ml) which directly induces cutaneous wheal and flare response, or codeine (usually 9% solution) which degranulates cutaneous mast cells, indirectly causing wheal and flare.

Devices used for skin testing

The basic conformation of the SPT utilises a sharp-pointed lancet to prick through the liquid allergen extract and into the skin, introducing the allergen into the epidermis and superficial dermis. Several different devices and configurations are available (Figure 3.1). In some cases the lancet or device is dipped into the allergen extract and then pricked into the skin; in other cases, the allergen extract is applied to the skin as a small droplet and pricked through with the lancet (Figure 3.2.C,D). The lancet tip is most commonly a single sharp point but it may have two points (duotip) or multiple sharp points. Lancets may come as single separate devices for each allergen or as a multi-point lancet to test multiple allergens simultaneously. The products shown in Figure 3.1 are available for use in Australia.

Some devices consist of a point, or multiple points on a flat plastic stopper or a flat metal piece with shoulders, so that the device can be “jabbed” perpendicularly onto the patient’s skin entering the epidermis and upper dermis, without penetrating too deeply (Figure 3.1.A, B, C, G). Alternatively, a sharp pointed device such as a prick lancet (Figure 3.1.F) can be used with an oblique “prick and lift” technique, without inserting the needle too deeply. The prick should not be deep enough to draw blood, although in the elderly with thin skin this may be unavoidable.

Hypodermic needles are not recommended.

Some practitioners advocate using the same device for several pricks, wiping on gauze or an alcohol swab between each one to reduce the chance of carry-over of allergen. Whilst this may be more economical, particularly when large numbers of allergens are being tested, studies have demonstrated that the risk of carry-over of allergens remains, and may vary between different allergens (Piette, Bourret, Bousquet, & Demoly, 2002; Kupczyk, Kuprys, Gorski, & Kuna, 2001). There is also the theoretical risk of injury to the practitioner during the wiping procedure, which could result in blood contact and needle stick injury.

For these reasons, multiple use of the same lancet device is not recommended, and should be avoided in some specific situations, such as food allergy testing in young children, where false positive tests results may have major significance with regard to dietary recommendations.

Skin prick test procedure**Requirements for skin prick testing procedure**

- Allergen extracts.
- Positive and negative control solutions.
- Sterile lancets for skin pricking.
- Sharps container for disposal of lancets.
- Marker pen for the skin.
- Ruler for measuring reactions.
- Tissues for wiping solutions.
- Recording sheets.
- Gloves (optional).

The patient needs to be in a comfortable position, with the forearms or back at a convenient height for the practitioner to do the test. The procedure should be explained to the patient (an information sheet can be provided), reassurance provided if necessary, and an enquiry should be made about medications that the patient is taking. Patients must have avoided antihistamines and other interfering medications as well as skin moisturisers prior to the procedure (see Appendix B). The area to be tested should be exposed with no risk of clothing brushing across the test area and wiping the test solutions (especially wiping the solution onto another prick location). The room should be private and at a comfortable temperature.

Site of application

Generally the most convenient and frequently used sites are either the volar surface of the forearm or outer upper arm, and the back. Reactions to allergen (but not histamine) are larger on average on the back than the arm (Nelson, Knoezner, & Bucher, 1996), larger on the lower back than the upper back, and larger on the upper forearm compared to the wrist. In the presence of appropriate controls these differences should not be clinically significant but because some small reactions can be close to the threshold for positivity, one study showed a slightly larger number of positive reactions on the back. However, the clinical significance of these was not investigated. Generally it is advisable to site tests more than 5cm from the wrist and 3cm from the antecubital fossa (Bernstein, & Storms, 1995).

Method

It is desirable (but not essential) to clean the skin site with alcohol prior to SPT. This may be contraindicated in cases of extreme dry skin and eczema. Positions for skin pricks should be marked by numbers on the skin to identify the allergen, and pricks should be made immediately adjacent to the numbers to avoid confusion between allergens. SPT should be at least 2cm apart to avoid overlapping reactions and false-positive results (Nelson et al., 1996). If a multi-test is used the orientation of the device should be marked and markings used to differentiate more than one device. Tape with numbers written on them is sometimes used with non-compliant children.

Drop then prick tests use a drop of allergen, applied from the dropper bottle onto the skin prior to pricking the skin. The drop on the tip of the dropper can be touched on the skin to transfer the liquid, but the tip of the dropper should not touch the skin. In cooperative patients or if a small number of allergens are used, all drops can be deposited before commencing pricking. In other cases it may be preferable to deposit a group of drops and prick them, then another group. In some cases, for example children with poor cooperation, it may be more practical to deposit each drop and prick each drop straight away. It is important not to allow the extract to run onto the next prick site. In patients with eczema who use moisturisers the drop may flatten or run more easily on the skin. Where many allergens are used it may be necessary to take into account the time that the first pricks are done compared with the last ones, when deciding the appropriate time to read the results. Whilst some practitioners leave the drops on the skin until the test is ready to read, this is not required. The test solution can be blotted from the skin after pricking without compromising the eventual result.

Dip then prick method the allergen extract is placed into small wells in a multi-well tray. The dropper (Duotip, Multitest, Quintips, Stallerpoint) is dipped into the allergen extract, withdrawn, and then applied to the skin with firm pressure (Figure 3.2.D). With the Duotip (Figure 3.1.D) some advocate twisting the lancet to slightly shear the two tips into the skin and allow more allergen to penetrate.

Comparisons of methods

There have been multiple small studies comparing SPT methods. Parameters determined have included mean wheal size to histamine, false positive rate (wheal with saline), false negative rate (no wheal to histamine), with both parameters of accuracy, and reproducibility of wheal size. Patient discomfort or pain has also been quantified. It is difficult to draw conclusions because most studies are small, most have studied only a subset of available devices, and there is significant variability in methodology. Many studies have used histamine and saline but few have used allergens. It is likely that there is significant operator dependence for most devices. No studies have examined whether certain devices are less operator-dependent than others.

Some themes have emerged. A direct comparison showed that twisting a dual-tip device increased the size of the histamine wheal but produced a significantly larger wheal to saline (potentially higher false-positive rate), and was more uncomfortable. Other studies showed that single prick devices were more sensitive and reproducible than multi-head devices (Yoon, 2006), that the end or outer heads of some multi-head devices were more prone to variable results due to uneven pressure on the heads, and metal lancets were more sensitive than the Stallerpoint plastic device (Masse, 2011). A recent study indicated poorer reproducibility of the “prick and lift” method using the Greer Pick or a Feather lancet, compared with the “puncture” method using Stallergenes Lancet or Quintip, when applied by recently trained practitioners (Werther, 2012).

It is recommended that practitioners try different devices and assess parameters such as cost, convenience, comfort and results.

Where clinical decisions may depend on wheal size it is important to maintain a single technique to maximise reproducibility. If wheal sizes are being compared with the literature, the technique and extracts used should be taken into consideration.

Time of reading results

The reaction to the histamine positive control is at its maximum size at approximately ten minutes whereas the allergen reaction reaches its maximum at around 15 minutes. In practice the histamine wheal is usually still showing at 15 minutes and this is recommended as the optimal time for reading skin test results. Occasionally allergen responses continue to enlarge up to about 20 minutes. Overall, the histamine result should be read at 10-15 minutes after the skin prick, and the allergens at 15-20 minutes. If the test is left for longer than 20 minutes the histamine and allergen response may diminish or be lost, and if not measured on time due to some delay, the test may need to be repeated.

Measurement of wheal and flare

The drops must always be carefully blotted from each test site prior to taking measurements; care should be taken not to cross-contaminate allergen test sites with the blotting tissue or the ruler used to measure the results. The standard and accepted method for quantifying the skin prick reaction is to measure the *mean diameter of the wheal*, using a ruler marked in mm (a transparent ruler is often most convenient; calipers are also available for this purpose). If the result is a circular wheal, one measurement of the diameter (in mm) is sufficient; if ovoid or irregular, it should be measured on the longest and shortest perpendicular axis and the numbers are added and divided by two (mean diameter). The flare may also be recorded by the same method. If flares are overlapping, then only the width of the flare in the non-overlapping region need be recorded. The result should be recorded as a single figure each for wheal and flare in mm. Some would argue that only the wheal should be recorded since flares show greater variability of measurement by observers. Pseudopods (irregular linear extensions of the wheal) are not included in the measurement, but may be marked separately; however, their significance is unknown.

Some practitioners advocate measuring the longest diameter; others use planimetry to produce a measurement in mm²; however mean diameter is easily measured and should be considered the standard.

If the test has been carried out by a nurse or technician, it is important that the skin reactions be inspected by the medical practitioner who ordered the test, to confirm the measurements and aid in interpretation, to monitor the quality of the test, and to determine whether any of the tests need to be repeated. For example, where there is an apparent discordance of results between allergens which are usually cross-reactive (e.g. d. pteronyssinus and d. farinae, rye grass and timothy grass), there may be a false negative due to incorrect pricking of the extract and the discordant allergens should be repeated.

Patient aftercare

Some patients experience considerable discomfort as a result of the itching of the skin test. Numbers should be removed from the skin, usually by cleaning with an alcohol solution (unless contraindicated by dry skin or a skin condition). Usually itching from SPT subsides within 15 minutes. Some measures may be taken to reduce discomfort, including topical creams to reduce itching such as urea creams (Urex), or an ice-pack. Topical corticosteroids are not useful (Kelso, 2007). Some practitioners recommend an oral antihistamine. There is no evidence for the relative effectiveness of these approaches.

Patients should be warned that there is a possibility of a late-phase reaction (LPR), although this is relatively uncommon with prick tests (more common with intradermal testing). The significance of the presence or absence of the LPR in SPT is unknown.

It is essential that the patient receive counselling regarding the significance of the test results from the medical practitioner who ordered the test, and receive information on any implications, for example allergen avoidance.

Post-test holding time

Because of the small risk of a systemic reaction occurring after the test has been completed, it is recommended that some patients should remain in the medical rooms for a period afterwards (Lockey, 2002). It is unnecessary to hold patients after a negative test, or where there have been only moderate SPT reactions to aeroallergens in a patient with no history of asthma. In the general setting, where there have been multiple positive results and there is a history of asthma or anaphylaxis, the patient should remain under observation for 40 minutes after the commencement of the test (approximately 20 minutes after completion of the test). Where additional risk factors exist such as severe asthma, use of beta blockers, pregnancy, testing with foods, latex, or medications, or intradermal testing (which would usually mandate that the test is carried out in a specialist setting), the 40 minute total observation time is essential.

SPT result reporting

Reporting forms

Following SPT a report should be generated which is clear, legible and enables communication of results to other practitioners. SPT result forms should contain the following information:

Name, address and contact information of the supervising practitioner (letterhead).

- Name and date of birth of patient.
- Date of test.
- Region tested (e.g. back, arm).
- Name of technician who carried out test.
- Name of each allergen tested, the correct name on the extract bottle should be used, followed by any common or local name.
- If the form contains a long list of allergens, some of which were not tested, these should be crossed out since leaving a blank space next to the allergen may lead to the assumption that they were tested but were negative.
- If the allergen solution is diluted from the standard concentration supplied, this should be recorded.
- Negative and positive controls should be listed; the positive control and its concentration should be identified.
- Size of the resultant wheal for each allergen.

Standardised quantitative reporting

The primary result of the test is the wheal mean diameter in millimeters, according to the measurement method and at the time suggested above, and this should always be clearly recorded. The mean diameter of the flare may also be recorded but this is optional. These parameters should also be recorded for negative and positive controls.

Method of recording SPT results

A chart should be kept and the wheal (and flare), size in mm recorded next to each allergen name. It is an essential part of good clinical practice to record the wheal diameter in numerical form, and to not use a qualitative marking (e.g. +, ++) as the primary reported result. Practitioners may find a qualitative scale to be clinically useful for test interpretation (e.g. in distinguishing borderline results, indicating clinical significance), but this should be a secondary part of the report. Such qualitative assessments should always be made by the medical practitioner inspecting the results after measurement. If a qualitative scale is used then the scale should be printed on the report form.

Qualitative scales

Qualitative scales quoted in the literature are highly variable and hence may confound communication and interpretation of results. Qualitative results may mean different things to different people since a number of different scales are used. The attachment of a qualitative statement to a report may convey an unintended meaning. For example, a “+” reading may be technically positive but not clinically significant, a “-” report does not exclude sensitivity to the substance tested by other, non-IgE mediated mechanisms (for example a negative SPT for wheat does not exclude celiac disease). Therefore qualitative reporting is subject to misinterpretation.

4. INTERPRETATION OF SPT RESULTS

Meaning of “positive” and “negative” tests

The result of a SPT may have significant ramifications to the patient’s lifestyle, diet, or occupation, and may determine prolonged courses of treatment and/or expensive environmental modification measures. The decision of whether a patient is truly allergic to the substance in question depends on careful interpretation of the SPT result as well as consideration of other clinical factors. SPT results need to be interpreted in the context of the patient’s history, clinical signs, and allergen exposures. In the presence of a history of an allergic condition (such as those listed in Section 2.1.1), with a positive SPT and known exposure to the allergen, particularly when the pattern of symptom exacerbation relates to variations in allergen exposure, it is reasonable to conclude that the allergen is relevant to the symptoms, and the positive test is significant.

A wheal of 3mm or greater is taken to indicate the presence of specific IgE to the allergen tested. When properly conducted, the SPT is a highly sensitive and specific test for the *presence of allergen-specific IgE antibody*. However, the presence of IgE antibody (as defined by a positive SPT) does not prove that the patient is clinically reactive to the allergen. The 3mm lower cutoff was determined because of reproducibility of measurement rather than clinical relevance (Dreborg, 2001). Studies have compared SPT results to the gold standard of clinical reaction to controlled challenge testing with the allergen. It is evident that in general, larger skin test reactions predict a higher likelihood of a positive response to a challenge, but do not predict severity of symptoms (Kanthawatana, Maturim, Fooanan, & Trakultivakorn, 1997; Clark, & Ewan, 2003). These studies have indicated that for many allergens, a wheal size (lower cutoff) set at a larger size than 3mm would correlate better with clinical allergen reactivity. For example, a wheal size of >6mm may provide more *specificity* for the diagnosis of *clinical* dust mite allergy than the 3mm wheal. However, this remains to be firmly established; it will vary with different allergens, extracts from different sources, and different populations. Therefore, a wheal of 3mm or greater is considered a positive SPT, but this must then be subjected to clinical interpretation.

Many precautions need to be taken in skin prick test interpretation:

- Positive tests (sometimes even with large wheal size) may occur without clinical symptoms. The test result indicates that IgE is present, therefore the test is technically positive, but symptoms may not occur on exposure to that allergen. This may be referred to as “clinically silent sensitisation”, or a “clinical false positive” test result (this individual may still be classified as atopic).
- The size of the SPT reaction may correlate with the likelihood that the patient is clinically reactive to that allergen. For example, in groups of patients, a subgroup with larger wheal size will contain a higher proportion of individuals who react to the allergen upon challenge than a subgroup with smaller wheal size.
- In general the size of the SPT reaction does not correlate with severity of the allergic manifestations.
- A positive SPT does not predict the nature of the allergic symptoms. Different individuals with a positive test to the same substance may react in very different ways on exposure to the allergen (or not at all).
- Positive allergy tests may indicate a clinically true allergy but may be irrelevant (e.g. the patient is sensitised and clinically reactive but not exposed to that allergen, hence it is not the cause of their symptoms).
- SPT may be positive when a patient has a previous history of allergy that has since resolved, for example allergic rhinitis may remit in adults but pollen skin tests often remain positive.
- Negative SPT results can occur even in the presence of true IgE-mediated allergy, due to inadequate representation of allergenic proteins in certain extracts.
- Negative SPT in children do not rule out the possibility of the future development of allergy.
- Real false positive and false negative tests occur occasionally in clinical practice, for technical reasons or because of human error. Real false positive or false negative tests are defined by being non-reproducible in the same individual.
- SPT is not appropriate for the diagnosis of non-IgE mediated allergy or intolerance. In some cases it is clear from the history that the adverse reaction is not caused by type-1 (IgE-mediated) allergy. Negative

skin tests in the presence of a good history of adverse reactions should prompt consideration of other mechanisms.

- When the SPT result is equivocal or does not correlate with the history, controlled challenge with the suspected allergen may be required (if clinically indicated and practical). Challenge testing is a specialised procedure.

Performance characteristics of SPT

Theoretically SPT is not a single test but a series of independent tests. Each test may have its own “performance characteristics” such as sensitivity, specificity, positive and negative predictive values etc. Ideally, the same rigor should be applied to technical aspects and interpretation of the results of SPT as is applied to laboratory tests. Laboratory testing is subjected to strenuous quality control and ultimately, independent external assessment and accreditation; laboratory test results are evaluated with reference to populations of test subjects, and statistical analysis is used to determine the diagnostic significance of a test result at a particular level.

Studies evaluating the diagnostic utility of SPT are of varying quality and frequently suffer from population selection bias, absence of blinding and absence of estimates of uncertainty. Published studies of SPT evaluation may be of great interest, but can be related only to the particular allergen and test method used. It is not advisable to directly translate wheal size in published studies to local practice unless the allergen extract is the same or is standardised, and the device, site of test and technique used is similar. Variability of SPT results using different devices and different brand extracts can be considerable and not only the size of the reaction but the result (e.g. positive/negative), can vary in the same individual (Rhodius, Wickens, Cheng, & Crane, 2002; Carr, Martin, Howard, Cox, & Borish, 2005).

Evaluation of the performance of a test usually requires reference to a “gold standard”; for allergy tests this is usually the controlled challenge. There are a number of reasons why controlled challenges may not be entirely representative of natural exposure to the allergen. Nevertheless, challenge often allows figures such as positive and negative predictive value to be calculated. The positive predictive value is the probability that a positive test represents a true allergy. Many studies are emerging which attempt to determine the extent to which a particular wheal diameter can predict the risk of clinical reaction on challenge with a food. These studies have been used to suggest that challenge testing (in the case of suspected food allergy), may not be necessary to confirm the diagnosis when the wheal reaches a certain diameter (Roberts, & Lack, 2005). However, it is crucial to recognise that the likelihood of true allergy for any given skin test size will depend on the pre-test probability that the study subject has the allergy. For example the pre-test probability of peanut allergy is different in a child with a history of urticaria after eating nuts compared with a child who has eczema but no history of nut ingestion, in whom the test is performed for screening purposes. Therefore, the predictive value varies in individuals with different histories, and may vary in hospital, specialist or general practice populations. A more useful figure is the likelihood ratio, which is a reflection of the degree to which the test result changes the probability that the patient has the allergy. These factors need to be taken into account not only in evaluating published studies but in applying the results of diagnostic testing to individual patients.

The importance of optimal interpretation of SPT results depends on the allergic condition in question and the allergen being tested. For example the erroneous interpretation of skin test results for aeroallergens in a patient with allergic rhinitis might result in inappropriate allergen avoidance strategies, which may be inconvenient, but erroneous interpretation of food allergy tests can have more serious consequences such as inappropriate dietary restrictions which might be deleterious to health, or inappropriate exposure to foods which might be dangerous. Therefore, taken together with the fact that skin testing for food is inherently more difficult to interpret, ASCIA suggests that it be restricted to specialist practitioners. When immunotherapy for inhalant allergens is being considered, the correct interpretation of SPT results becomes more critical since misdiagnosis may lead to inappropriate treatment, again it should be carried out by specialists in these circumstances.

Therefore, like any test used in clinical medicine the SPT is only one part of a comprehensive assessment of the patient and if the result is discordant with all of the other clinical indications, there may be grounds to repeat the test under different conditions or use another method (such as serum specific IgE test, or diagnostic challenge). Interpretation of skin test results should be carried out by an experienced practitioner who is familiar with all of these factors.

5. PERSONNEL

SPT is routinely carried out by allergy specialists, where it is considered an extension of the physical examination. They may also be carried out by some general practitioners and other specialists (paediatricians, general physicians, thoracic physicians), who have additional training in allergy. In these circumstances it is a point of care test (POC), where the medical practitioner who is consulted by the patient provides the test and interprets the results. However, there is currently no certification or accreditation for performance of this test. Skin testing carried out in a medical practitioner's rooms should conform to the minimum and/or optimum standards for skin testing specified in this document (Appendix A) and endorsed by ASCIA. SPT is also carried out in some respiratory laboratories and pathology laboratories; the standards in Appendix A apply in these settings.

Role of medical staff

The role of the medical practitioner in allergy SPT is to:

- Ensure that an appropriate environment for SPT is in place and that trained staff, equipment, reagents and facilities are available; according to standards set out in Appendix A.
- Assess the patient, history and examination, formulate a differential diagnosis, assess the likelihood of allergic disease, and consider indications for SPT, whether additional information is likely to be provided by SPT and whether management will be altered by the results of SPT.
- Carefully consider any contraindications or factors which might interfere with SPT.
- Advise the patient of the procedure including risks and benefits.
- Decide on which allergens or panels of allergens should be tested, based on the symptom pattern, patient exposure, and using information about allergens in the local environment.
- Consider location to be tested, for example back or arms.
- In some cases the medical practitioner will personally carry out all steps of the SPT.
- If not carried out by the medical practitioner personally:
 - Advise paramedical staff of the test panel required and any patient characteristics that will need to be known to complete the test reliably and safely.
 - Be present and available in case of any adverse symptoms experienced by the patient.
 - Inspect the test site at the conclusion of the test to verify measurements taken by the person who carried out the test and determine whether there are any factors that might affect the interpretation of the results.
- Interpret the meaning of the measured results in the context of the clinical assessment.
- Consider whether technically positive skin test results are clinically important and whether negative test results are potentially false negative.
- Determine final diagnosis and management plan.
- Counsel the patient on the meaning of the results and their diagnosis and management.

Medical practitioners involved in allergy testing should maintain a good knowledge of allergic diseases, of allergens relevant in their area, and the significance of particular SPT reactions in relation to the condition in question. An example might be the relative importance of allergy to dust mite, animals, pollens and foods in a case of atopic dermatitis. The evidence base for effectiveness or otherwise of allergen avoidance measures and immunotherapy must be taken into account when advising patients on management based on allergy test results.

Role of nursing staff and technicians

Appropriately trained and experienced nursing staff, and in some cases technicians may play a role in certain aspects of the allergy skin test and resulting management.

The role of nurses or technicians in SPT is to:

- Counsel the patient prior to the test on what to expect, put them at ease, and position the patient appropriately and comfortably.

- Carry out the test according to the steps described above (e.g. apply numbers to skin, apply allergens, prick through the skin, and measure results).
- Management of the skin test record chart including patient details and recording results as described above.
- Monitoring patient for adverse reactions, reassurance regarding normal sensations.
- Aftercare of test site.
- Provision of patient education in allergen avoidance or adrenaline (epinephrine) autoinjector use (on request by the medical practitioner, when indicated), if appropriately trained to do so.

Training

Clinical immunology/allergy specialists undergo extensive training at a postgraduate level under the RACP and/or RCPA, which includes proficiency and experience in all aspects of skin testing for allergy. There is no formal training for other specialists or general practitioners who conduct allergy testing. Allergy seminars and allergy testing workshops have been run by specialist units. Workshops on SPT have been held at some ASCIA Annual Conferences.

Postgraduate training in allergy has been available for nurses from 2006 as part of the Allergy Nurses Course offered by UniSA (University of South Australia). This course covers a range of topics in allergy relevant to nurses, and includes theoretical and practical training in skin testing, as well as hands-on training with a preceptor.

It is suggested that at least ten skin tests over several days on a variety of patients should be carried out under supervision of an experienced nurse and allergy specialist to ensure basic competency. Evaluation of proficiency has been suggested by a test in which a minimum of ten histamine pricks are carried out on five different individuals, and the CV ($SD \times 100 / \text{mean}$) should be less than 20% (Dreborg, 2001).

Due to increased risk and greater complexity of interpretation, skin prick testing below the age of two years should generally be considered a specialist practice. However, testing in children below the age of two years may be performed by suitably trained medical practitioners with appropriate facilities in some circumstances.

Examples of these circumstances may include when a patient is in shared care with allergy specialists or when an allergy specialist is not readily available due to distance and/or waiting lists. It should be noted that since atopic dermatitis and asthma are very common and SR are extremely rare, the presence of atopic dermatitis and/or asthma should not preclude skin testing in the appropriate setting.

6. SAFETY AND RISKS

Safety/risks of SPT

SPT is an extremely safe procedure, with minimal discomfort. Rarely, adverse events can occur; these can be classified into allergic, test-related non allergic, and nonspecific. Examples of test-related non-allergic might include transmission of infection (theoretical but never documented); examples of nonspecific are syncope, headache etc. Vasovagal syncope is relatively common and if the test is done on the patient in the sitting position, facilities should be available for the patient to lie down if feeling faint.

The expected reaction to a SPT is a localised wheal and flare. Delayed local skin swelling (the late phase response), which is often tender or painful may occur uncommonly as a result of an IgE-mediated late-phase reaction. Rarely this can cause swelling and discomfort, however, it does not usually last more than 36 hours.

Systemic introduction of allergen may occur as an unintended consequence of the skin prick. Systemic reactions (SR) from SPT have been recorded, including the typical manifestations of anaphylaxis such as generalised urticaria, angioedema including airway angioedema, bronchospasm, and hypotension. These reactions are generally mild and respond to treatment with standard measures. There are many case reports of systemic allergic reactions from SPT (Liccardi et al., 2006) although in large case series this is exceedingly rare. In a survey of 16,000 individuals tested with eight routine allergens, the rate of AR was 0.04% (Turkeltaub, & Gergen, 1989), but most of these were syncope, near-syncope or malaise. In another large survey, the rate of systemic allergic reactions was 0.033%, all occurring in asthmatics (Valyasevi, Maddox, & Li, 1999).

A small number of fatalities are recorded as a result of IDT. There has only been one reported fatality from SPT, however, this was an atypical case and many of the risk factors mentioned below were present (Bernstein et al., 2004). Delayed SR in association with large late-phase responses have rarely been reported. These usually consist of wheezing in asthmatic patients who had strongly positive SPT, commencing several hours after the test. All asthmatics should have an appropriate action plan in place, particularly where there are multiple strong positive SPT reactions.

Case reports or small series describing anaphylaxis from skin testing have suggested certain risk factors. Amongst a paediatric population, SR occurred exclusively in infants less than six months of age with atopic dermatitis, when tested with fresh food allergens (Devenney, & Falth-Magnusson, 2000). Further case reports suggest that a history of anaphylaxis to food, particularly when testing with fresh food allergens and multiple allergens, is a risk factor (Novembre, Bernardini, & Bertini, 1995). Systemic reactions from skin testing with latex extracts have been well described.

Known risk factors for anaphylaxis in SPT include:

- Less than six months of age (though possible at any age).
- Previous history of food anaphylaxis, testing with foods.
- Testing with fresh foods, non-commercial extracts.
- Testing with latex allergens.
- Asthma, particularly if active or unstable.
- Widespread atopic dermatitis in children.

Safety measures and safety equipment required

SPT must always be performed in a medical setting with the availability of medical practitioners competent to treat systemic allergic reactions, and appropriate equipment. It is recommended that patients who have undergone SPT and have positive results, who have asthma or a history of anaphylaxis, should remain in the centre for at least 20 minutes following completion of the SPT (total of 40 minutes after skin pricking).

Suggested minimum standards for available emergency equipment and medications:

- Availability of oxygen, 6l/min via mask.
- Facility for intravenous cannulation and intravenous fluids for rapid infusion in case of hypotension.
- Ready availability of adrenaline for intramuscular injection.
- Salbutamol via nebuliser or spacer.

Detailed information on the treatment of systemic allergic reactions and anaphylaxis are on the ASCIA website www.allergy.org.au/anaphylaxis

Appendix A: Standards for skin prick testing

This set of standards is based on ASCIA expert consensus as well as published evidence. It should be read in conjunction with the ASCIA SPT guide which provides explanation, references and justification.

Minimum standards for SPT

Patients must be screened for suitability for SPT by a medical practitioner taking into account indications and contraindications.

- Asthma, pregnancy, beta-blocker use are relative contraindications to SPT.
- Allergens to be tested (or panels of allergens), must be ordered individually based on patient history and exposure.
- Patients should not be tested if they have recently taken antihistamines or other medications which interfere with the test response, or on skin with active dermatitis or open lesions.
- A medical practitioner must be present on the premises during the conduct of the procedure.
- Appropriate medications and equipment to treat anaphylaxis must be readily available.
- The test must be conducted by a practitioner (nurse or doctor) who has training and experience.
- The test must incorporate a positive control (histamine or codeine) and negative control.
- Test sites should be at least 2cm apart.
- The test result should be inspected and measured at 15 minutes.
- The diameter or mean diameter of the wheal must be recorded as the primary result of the test.
- A wheal of 3mm is the minimum size to be considered a positive result.
- An experienced medical practitioner should inspect the results of the test.
- Allergen extracts should be obtained from reliable commercial sources, stored at 2-8°C when not in use, and discarded after the use-by date.
- Appropriate devices should be used for skin pricking (hypodermic needles are not suitable).
- Sharps must be disposed of appropriately, with universal precautions for infection control observed.
- A report should be provided stating the name of the medical practitioner who ordered and inspected the test, the patient's name, the date, the site used, the allergens tested, and results as wheal diameter (in mm).
- Results must be interpreted in the context of the patient's history.
- Post-test counseling must be provided based on the results.

Patients with a history of asthma who have positive SPT results should be observed for at least 20 minutes after completion of the test. This holding time is also applied in any other higher risk patients (see below, "skin test procedures that should only be conducted by allergy specialists"). If the test is negative, or positive for aeroallergens where there is no history of asthma, a holding time is not mandatory.

Minimum requirement to claim a Medicare rebate for allergy SPT

In order to claim the item, the medical practitioner must review the patient history and order the panel, and attend the patient to interpret the results (HIC advice).

Optimum standards for SPT

The same medical practitioner who orders the test should inspect the results and provide post-test counselling (or the medical practitioner may conduct the entire test).

- A new pricking device should be used for each allergen and control.
- Standardised extracts should be used where possible.
- The flare diameter as well as the wheal should be recorded.

- The histamine result should be read at ten minutes, the allergens at 15-20 minutes.
- Following the test, comprehensive patient education on allergen avoidance should be provided if indicated.

Skin test procedures that should only be conducted by allergy specialists or equivalently trained medical practitioners include:

- SPT for foods, particularly fresh foods.
- SPT for latex allergy and drug allergy.
- IDT for medications and venoms.
- SPT on infants less than two years of age.
- Skin testing in the presence of relative contraindications such as pregnancy, use of beta-blockers, severe or unstable asthma.

Skin test procedures that are usually inappropriate/contraindicated include:

IDT for foods (very high risk), aeroallergens (lack specificity).

Skin tests are not indicated for the diagnosis of food intolerance, adverse reactions to food additives, and allergy to most medications.

Appendix B: Medications which are antihistamines or have antihistamine activity and which may interfere with skin testing

Generic names	Commercial names	Withholding period (days)	Comments
Brompheniramine	Demazin*, Dimetapp*	5	Withholding period varies in individuals due to different rates of metabolism; four days is recommended as general advice.
Cetirizine	Alzene, Cetrelief, ZepAllergy, Zilarex, Zodac, Zyrtec	4	
Chlorpheniramine	Codral*, Demazin*, Dimetapp*, Logycin*, Sudafed*, Sinutab*	4	
Cyproheptadine	Periactin	4	
Desloratadine	Aerius	4	
Dexchlorpheniramine	Polaramine	4	
Diphenhydramine	Benadryl, Paedamin, Snuzaid, Unisom Sleepgels	2	
Dimenhydrinate	Travacalm		
Doxylamine	Dolased, Codagesic, Codalgin, Dimetapp*, Dozile, Fiorinal, Maxydol, Mersyndol, Panalgesic, Restavit, Tensodeine	2	
Fexofenadine	Allerfexo, Fexo, Fexal, Fexorelief, Fexotabs, Tefodine, Telfast, Xergic	4	
Levocetirizine	Xyzal	4	
Loratadine	Alledine, Allerdyne, Allereze, Claratyne, Lorano, Lorapaed, Lorastyne	10	Usually four days is sufficient
Pheniramine	Avil	4	
promethazine HCl	Allersoothe, Avomine, Phenergan, Fenezal	4	
trimeprazine	Vallergan	2	
triprolidine	Codral*, Sudafed*	1	
H-2 antagonists			
cimetidine	Magicul, Tagamet	1	There may be only minimal suppression of the skin test
ranitidine	Ausran, Rani-2, Ranital, Ranoxyl	1	
famotidine	Ausfam, Famohexal, Pamicid, Pepcidine, Pepzan	1	
Antidepressants			
amitriptyline	Endep		Withholding period not established, antihistamine effect variable but often significant.
clomipramine	Anafranil Placil, generic		
dothiepin	Dothep		
doxepin	Deptran, Sinequan	7	
imipramine	Tofranil, Tolerade		
mianserin	Lumin, Tolvon		
mirtazapine	Aurozamine, Avanza, Axit, Mirtazon, Milivin, Remeron		
trimipramine	Surmontil		
Anti-migraine			
pizotifen	Sandomigran		

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Anti-emetics			
prochlorperazine	Nause til, Nausrelief, Prozine, Procalm, Stemetil, Stemizine		Weak antihistamine
Neuroleptics			
chlorpromazine	Largactil		Withholding period not established, may be up to two weeks Antihistamine effect variable between medications and individuals.
clozapine	Clopine, Clozaril, Closyn		
flupenthixol	Fluanxol**		
fluphenazine	Modecate		
olanzapine	Lanzek, Ozin, Zylap, Zypine, Zyprexa		
pericyazine	Neulactil**		
quetiapine	Delucon, Quetiaccord, Quipine, Sequase, Seronia, Seroquel, Syquel		
risperidone	Ozidal, Resdone, Rispa, Risperdal, Rispericor, Rixadone		
zuclopenthixol	Clopixol**		

* Multiple preparations under this name, check label.

** Antihistamine effect not formally demonstrated but thought to be due to structural and functional similarities with other medications.