Practical aspects

• Preparation
• Aspiration
• Speed
• Route
• Injection site
• Needle size
• Simultaneous injections
• Parental/Nurse demeanour
Preparation

• Warming prior to injection does not reduce incidence of pain\(^1\)
• Pre-cleansing of injection site? No need for alcohol wipe\(^2, 3\)
• Change the needle between drawing up and injecting?
  Practitioners have always felt this glides needle through skin

DoH Green book now recommends\(^4\)

Aspiration

Pulling back on the syringe plunger before injection to check for blood return

- Entrenched in nursing textbooks since 1930’s
- No evidence to document necessity\(^1,2\)
- DoH advise this is not needed

Does speed of injection affect pain?

- RCT: two techniques in 113 infants
- Standard care: slow aspiration, injection & withdrawal
  Pragmatic care: no aspiration, rapid injection & withdrawal
- Immediate infant pain measured by Modified Behavior Pain Scale (MBPS), Crying, Parent/paediatrician VAS
- Pragmatic rapid injection technique was less painful than slow standard of care technique
- Rapid injection technique is recommended

Simultaneous injection by two practitioners

- When two injections are required, some practitioners have chosen to give both injections simultaneously.
- Studies showed ‘no detectable decrease in discomfort in the child’ compared with administering the injections sequentially\(^1,2\).
- However, this is effective in reducing anxiety in older children (need to inform parent in advance).

Which route for vaccination?

**Intramuscular**
- DTaP/Hib/IPV
- MenC
- Pneumo conjugate
- Pneumo polysaccharide
- Hep A, Hep B
- Influenza
- Typhoid (Vi vaccine)
- Rabies

**Intradermal**
- BCG

**Subcutaneous**
- MMR (SC or IM)
- Varicella
- Yellow Fever

**Oral**
- Rotavirus
- Cholera
- Oral typhoid
Injection route

Technique determines where vaccine is placed (ID, IM, SC)

- Angle of the injection
- Whether the tissue is stretched or bunched up
- Depth of needle insertion
Route: Intradermal delivery

- BCG into left arm
- Insert needle at 10-15° angle
- Bevel upwards, place just under epidermis
- Should be able to see the bevel through skin
- Should feel resistance
- Injection should raise a bleb

Immunisation handbook
www.dh.gov.uk
Route: Intramuscular

- Why are most given IM?
- Most contain aluminium adjuvant
- Adjuvants help stimulate an immune response (are less reactogenic in muscle)
- Muscle has a better blood supply
- Quicker mobilisation & processing of antigens
- Optimises antibody production
- IM delivery minimises local side effects

Intramuscular injection technique

- Skin stretched flat between thumb & index finger
- Optimize insertion deep into muscle
- Inserted at 90° angle
- Needle length long enough to reach muscle

**Route: Subcutaneous**

- Skin is bunched up
- Ensures insertion into fatty tissue just below skin
- Inserted at 45° angle
- Needle length shorter to reduce chance of insertion into muscle

*Source: Diggle L. Injection technique for immunisation. Practice Nurse 2007; 33 (1).*
Why not SC?

- Poorer drainage channels in fat
- Lack of antigen presenting cells
- SC fat retains injected material for longer
- More susceptible to any adverse effects of injection
- Used for live virus vaccines requiring a slow, sustained release into the capillary network

Injection site?

• Determined by - route to be used
  - amount of vaccine to be injected
  - age & size of the patient

• IM injection to Pre-schooler/Adolescent/Adult
  Deltoid (antero-lateral aspect of thigh)

• IM injection to 2, 3, 4 month old infants
  Antero-lateral aspect of thigh
  Away from neurovascular bundle: femoral nerve, artery, vein
Antero-lateral thigh

Upper third: Greater trochanter of femur, Level of greater trochanter

Middle third: Vastus lateralis muscle, Rectus femoris muscle

Lower third: Lateral femoral condyle, Femur, Patella

Cross-section of the left thigh

Site at age 12/13 months

- Usually thigh is used
- Deltoid is probably large enough for an IM injection after 12 months\(^1,2\)
- WHO state 15 months\(^3\)

1. Green Book - procedures chapter
2. 2003 Australian Immunisation Handbook
3. WHO 2005

Why not use the buttock?

- Infants: sciatic nerve position variable
- Reduced immunogenicity of Hep B\textsuperscript{1} & rabies\textsuperscript{2} vaccines
- Adults: amount of S/C fat necessitates a needle >35mm (1½ inch)

1. MMWR (1985) Suboptimal response to hepatitis B vaccine given by injection into the buttock; 34:105-8,113.
“Fortunately, medical researchers have been able to combine tetanus, smallpox and rubella vaccinations into one shot.”
Needle size for adults?

Men

- 25mm for deltoid (60-118 kg)

Women

- 25mm for deltoid (60-90kg)
- At least 38mm for weights over 90kg (>14 stone)

Needle size for infants?

- Needles vary in length & diameter
- Blue 25mm
- Orange 16mm
- Not known if this mattered
4 mths of age: Blue 25mm needle gave less local reaction

Diggle L, Deeks J. Effect of needle length on incidence of local reactions to routine immunisation in infants aged 4 months: randomised controlled trial

BMJ 2000; 321: 931-933
Unanswered questions

• Did the size of needle matter for local reactions at ages 2 & 3 months?

• Was it length or gauge that made the difference to local reaction incidence?

• Did the size of needle make a difference to protection?

Source: World Health Organisation
Effect of needle size on immunogenicity and reactogenicity of vaccines in infants: randomised controlled trial

Linda Diggle 1*, Jonathan J Deeks 2, Andrew J Pollard 1

1 Oxford Vaccine Group, Centre for Clinical Vaccinology and Tropical Medicine, Department of Paediatrics, University of Oxford, Churchill Hospital, Oxford OX3 7LJ
2 Department of Public Health and Epidemiology, University of Birmingham, Birmingham

* Correspondence to: linda.diggle@paediatrics.ox.ac.uk

Objectives To assess the immunogenicity of vaccines for infants and to investigate whether the incidence of reactogenicity is reduced after each immunisation dose using needles of varying lengths and gauges.

Design Randomised controlled trial.

Setting 18 general practices within two UK primary care trusts.

Participants 696 healthy infants vaccinated at 2, 3, and 4 months of age, with follow-up to 5 months of age.
Comparison of 3 needle sizes

1. Blue wide long needle
   23G 25 mm (1-inch)

2. Orange narrow short
   25G 16 mm (5/8 inch)

3. Orange narrow long
   25G 25 mm (1-inch)

Needle gauge diameters:
23G = 0.6mm
25G = 0.5mm
Study design

696 infants enrolled when attending for 1st vaccination dose

Randomisation

- Blue long needle
  - 240 infants
  - 95% completed diaries
  - 89% blood draw*

- Orange short needle
  - 230 infants
  - 93% completed diaries
  - 85% blood draw*

- Orange long needle
  - 226 infants
  - 96% completed diaries
  - 91% blood draw*

*Blood draw at 28-42 days after 3rd dose DPT/Hib and Men C
Any local reaction 1st dose
DTwP/Hib (2 months)

% of infants

6 hours
RR 0.89
(0.79, 1.01)

Day 1
RR 0.69
(0.57, 0.84)

Day 2
RR 0.53
(0.38, 0.74)

Day 3
RR 0.46
(0.27, 0.80)

post-immunisation

P = 0.06

P = 0.0002

P = 0.0001

P = 0.004

Wide long
Narrow short

P = 0.06
P = 0.0002
P = 0.0001
P = 0.004
Any local reaction 2\textsuperscript{nd} dose (3 months)

<table>
<thead>
<tr>
<th>Time</th>
<th>RR</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 hours</td>
<td>0.95</td>
<td>(0.80, 1.12)</td>
</tr>
<tr>
<td>Day 1</td>
<td>0.76</td>
<td>(0.62, 0.92)</td>
</tr>
<tr>
<td>Day 2</td>
<td>0.65</td>
<td>(0.49, 0.85)</td>
</tr>
<tr>
<td>Day 3</td>
<td>0.59</td>
<td>(0.39, 0.90)</td>
</tr>
</tbody>
</table>

P = 0.4
P = 0.01
P = 0.001
P = 0.01

Wide long
Narrow short
Any local reaction 3\textsuperscript{rd} dose (4 months)

<table>
<thead>
<tr>
<th>Time</th>
<th>RR</th>
<th>(95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 hours</td>
<td>0.92</td>
<td>(0.78, 1.08)</td>
<td>0.4</td>
</tr>
<tr>
<td>Day 1</td>
<td>0.78</td>
<td>(0.64, 0.94)</td>
<td>0.01</td>
</tr>
<tr>
<td>Day 2</td>
<td>0.76</td>
<td>(0.57, 1)</td>
<td>0.05</td>
</tr>
<tr>
<td>Day 3</td>
<td>0.54</td>
<td>(0.34, 0.85)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

% of infants with any local reaction 3\textsuperscript{rd} dose (4 months)

- Post-immunisation
  - Wide long
  - Narrow short

P values for comparisons:
- 0.4
- 0.01
- 0.05
- 0.003
Severity of reaction also less with longer needle

<table>
<thead>
<tr>
<th></th>
<th>Wide long (n=240)</th>
<th>Narrow short (n=230)</th>
<th>Narrow long (n=226)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large local reaction</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>contra-indicating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>receipt of further</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>whole-cell pertussis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>containing vaccine*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 7.94$, $df = 1$, $p=0.005$

Same length, different gauge?

- There were no significant differences in incidence of local reactions
Did needle size affect protection?

• Do the vaccines work just as well with the blue long as with the orange short needle?
• If study again showed a reduction in local reactions with the blue long needle (but the vaccines worked just as well) - this would be sufficient to recommend the longer needle as best practice for infant immunisation
Blue 25mm works just as well as the shorter needle

<table>
<thead>
<tr>
<th>Condition</th>
<th>Ratio (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meningitis C</td>
<td>1.30 (0.99, 1.69)</td>
<td>0.004</td>
</tr>
<tr>
<td>Hib</td>
<td>1.05 (0.78, 1.42)</td>
<td>0.16</td>
</tr>
<tr>
<td>Tetanus</td>
<td>1.01 (0.84, 1.22)</td>
<td>0.10</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>1.13 (0.91, 1.39)</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Our research demonstrated that:

- Local reactions were less with longer (25mm) needle at 2, 3, 4 months
- Needle gauge made no difference to reaction rates
- Evidence favoured longer needle achieving comparable, if not, superior immunogenicity
- No evidence to indicate results would be any different for other vaccines
- For best practice - use 25mm needle for term infants
- Use clinical judgement for prems/LBW infants
Needle length: 4 to 6 yrs

- US study of 1315 children aged 4-6yrs (5\textsuperscript{th} dose DTaP)
- Prospective assessment deltoid injection
- 25mm needle (793 children)
- 16mm needle (381 children)
- Not randomly assigned to needle size but analyses adjusted for BMI
- Higher risk of redness & pain with shorter needle

Two injections into one leg

• Common practice in US¹
• Infant A/L thigh can accommodate two IM injections
• Need to be at least 2.5cms (1 inch) apart so that reactions don’t overlap²
• Be consistent/record which one went where

¹. American Academy of Paediatrics 26th ed. 2003,
². Dept of Health, Immunisation procedures chapter

Demo at www.prevenar.co.uk
Three injections to infants?

1. Pediacel in left A/L thigh
2. Men C in left A/L thigh (2.5cm away)
3. Prevenar in right thigh

NHMRC 2003 Australian Immunisation Handbook
# Assessment Tool for Immunisation

This document can be used as a self-assessment tool for practitioners who administer immunisations. To complete it, review the competency areas below and the clinical skills, techniques and procedures outlined for each of them. Score yourself in the Self-Assessment column. If you tick Need to Improve you indicate further study, practice or change is needed. When you tick Meets or Exceeds you indicate you believe you are performing at the expected level of competence, or higher. Mentors: Use this checklist to clarify responsibilities and expectations for those who administer vaccines. Next observe their performance as they provide immunisations to several patients and provide a score in the Mentor Review column. If improvement is needed, help the immuniser to develop a Plan of Action that will help them achieve the level of competence you expect. Circle desired actions or write in others. When all competency areas meet expectations, mentors should take a copy of this document for their records; immunisers should keep this document within their PREP/CPRD folder.

<table>
<thead>
<tr>
<th>Competency</th>
<th>Clinical Skills, Techniques and Procedures</th>
<th>Self-Assessment</th>
<th>Mentor Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Patient/parent education</td>
<td>1. Welcome patient/family, establish rapport.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>2. Check patients record, confirming with patient/parent to ascertain previous immunisation history. Verify appointment on the childhood schedule if appropriate.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>3. Explain what vaccines are to be given today, inform of any expected adverse effects or answers any questions referring to DHF leaflets or similar explanations as appropriate.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>4. Use language appropriate to the child’s interpreter as appropriate to ensure patient/parent informed.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>5. Ensure you are conforming to applicable patient group direction/provision and be aware of scope and limitations of POSIs. For infants, ensure 6 week check has been performed.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>6. Ensure informed consent is obtained prior to vaccination and be aware of issues applicable to complications and age of patient.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>7. Screen for contraindications (referring to Green Book chapters as appropriate)</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>8. Know who to contact for advice if unsure about vaccination schedules, spacing or compatibility of vaccines</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td>B Medical Protocols</td>
<td>1. Ensure anaphylaxis equipment is readily available.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>2. Be aware of appropriate dosage, how to administer it when to use it.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>3. Maintain up to date basic life support skills (mandatory yearly).</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>4. Be aware of protocol to follow in case of needlestick injury.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>5. In case of an adverse incident during vaccination procedure (e.g. allergic reaction; needlestick injury), be aware of incident reporting procedure as per local protocol.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td>C Vaccine preparation</td>
<td>1. Demonstrate an understanding of the rationale for maintaining the cold chain of a vaccine, state the correct temperature range for vaccine storage and explain the system you are using to monitor the vaccine fridge.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>2. Be familiar with local protocols for cold chain audit and action to be taken in case of cold chain failure.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>3. Demonstrate knowledge of aseptic vaccine handling, e.g. protection of vaccine from light.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>4. Prior to reconstitution of vaccine, check vaccine and expiry dates.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>5. Wash hands and correctly reconstitute vaccine as appropriate, ensuring vaccine is held as a freeze-dried and lyophilized powder are fully mixed in well.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>6. Ensure informed consent is obtained prior to vaccination.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
<tr>
<td></td>
<td>7. Select correct needle size according to the evidence base.</td>
<td>Need to Improve</td>
<td>Meets or Exceeds</td>
</tr>
</tbody>
</table>
Parental demeanour

- Parental demeanour significantly influences the amount of pain & distress children experience.
- Excessive parental reassurance, criticism, apology, giving control to the child were associated with increased child distress.
- Humour, distraction, matter of fact, supportive non-apologetic approach tends to decrease distress.

Schechter et al, Pain Reduction During Pediatric Immunizations: Evidence-Based Review and Recommendations Pediatrics 2007;119;e1184-e1198
In summary

- No need to warm, cleanse or aspirate
- Speedily is best for IM injection delivery
- Most immunisations should be IM
- Antero-lateral thigh for infants
- May use deltoid >1yr
- Use 25mm needle for infant thigh, pre-school deltoid
- At least 25mm for adult deltoid
- Parental demeanour significantly reduces child’s distress
- Practice should be evidence based
‘And here’s a lollipop for being so brave’
Dr Linda Diggle
Public Health Dept, Le Bas Centre
St Saviour’s Rd, St Helier
Jersey, JE1 4HR
Tel: 01534 443793 l.diggle@health.gov.je