EVIDENCE BASED IMMUNISATION PRACTICE

12TH JUNE 2024 IMMUNISATION CONFERENCE

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CONTENT

- Best practice when immunising babies at 2, 3 & 4 months of age
- Why technique matters
- Why needle size matters
- Strength of evidence



THE BACKGROUND....



- In 1998, 4 million infant vaccines were administered in UK
- Needles varied in gauge (diameter) & length
 - Blue hub (wider gauge), 25mm (1 inch) length
 - Orange hub (narrower gauge), 16mm (5/8 inch) length
- Each DPT/Hib vaccine pack came with an orange needle only
- Local opinion leader in Oxfordshire advised immunisers to use the blue needle to vaccinate infants
- What should I be teaching? Which of these is right?



Photo courtesy Lloyd Ellis, RCH, VIC



Source: The Australian Immunisation Handbook https://immunisationhandbook.health.gov.au

EVIDENCE BASE ON NEEDLE SIZE WAS LACKING

- Claim of less redness/swelling post vaccination if blue needle used
 - Anecdotal evidence only
- One published paper* supported inclusion of orange hub needle in uni-dose vaccine packs
 - Ultrasonography of thigh muscle in 40 infants within a children's hospital
 - "16mm needle adequate to reach vastus lateralis muscle if skin is stretched flat & needle is inserted at 90° angle to skin"
 - Infants all between 10th & 50th percentiles of normal growth charts
- Problem: Immunisation technique varied amongst immunisers

INTRAMUSCULAR INJECTION TECHNIQUE

- Stretch skin flat between thumb & index finger
- Insert at 90° angle
- Optimize insertion deep into muscle
- Needle length needs to be long enough to reach muscle



Picture source: Diggle L. Injection technique for immunisation. *Practice Nurse* 2007; 33 (1)

World Health Organization (1998) *Immunization in Practice: Module 8, During a session giving immunizations*, Geneva, WHO.

'IM' TECHNIQUE SURVEY OF 100 PRACTICE NURSES

Injection technique used to give an intramuscular injection	Number of nurses
Stretch skin taut, inject at 90° angle	25
Stretch skin taut, inject at 45° angle	7
Bunch-up skin, inject at 90° angle	56
Bunch-up skin, inject at 45° angle	8
Other	4

Diggle, L. (1999) Option recorded by 100 vaccinating nurses when asked to indicate which technique best described their intramuscular technique used to deliver infant vaccinations

MY RESEARCH QUESTIONS

- 1. Of the two needles that are available and in use, does either make a difference to redness, swelling, pain experienced by babies at 2, 3 & 4 months of age?
- 2. Does the size of the needle make any difference to how well babies are protected babies against disease?
- The answer to these two questions would provide the evidence for immunisation practice
- The most robust study design to answer these questions was a randomised controlled trial

FUNDING NEEDED TO CONDUCT AN RCT

- I wrote a formal research proposal
- I consulted a statistician to determine the sample size
- 750 infants would be required to participate in an RCT
- Venous blood sample would be required from each infant
- Laboratory analysis was therefore required
- Dedicated study nurses to immunise/take venous blood sample from each infant required
- I spent a long time searching for funding without success!!
- How could I move forward?

I SIMPLIFIED THE STUDY TO REDUCE COSTS

- Awarded a £5000 Nursing Research Scholarship by the Smith & Nephew Foundation (equivalent to £11,000 today)
- Simplified the study to answer only the local reaction question
- Ethics approval & all necessary permissions obtained
- Approached surgeries & asked PNs in Buckinghamshire to help me conduct the study



REVISED RANDOMISED CONTROLLED TRIAL DESIGN

- 250 infants would be randomised to receive vaccines using either orange or blue needle
- Parents of babies due immunisations would be informed by letter about the study
- Parents attending surgeries for injections would be asked if they wished to take part
- Following informed consent, sealed envelope opened by PN to tell her which needle size to use
- Post each injection, parents would record local reaction rates for 3 days using standardised reaction diary
- Data from each group would be compared to determine redness, swelling, pain after injection

BUT.. NURSES WERE RELUCTANT TO USE LONGER NEEDLE



- Nationally, uni-dose vaccine pack contained the manufacturer's orange 16mm needle
- Buckinghamshire PNs were reluctant to use the longer blue needle on 'young babies'
- However... they felt they use for 3rd set of imms
- Whoopee!!

SO, I REWROTE THE STUDY PROTOCOL....AGAIN!!!

- Parents of infants attending surgeries for 3rd set of immunisations (aged 4 months) would be asked if they wish to take part
- Following informed consent, PN opens sealed envelope
- This would randomise infant to receive 3rd DPT/Hib with either a blue or orange needle
- I taught a standardised technique to the PNs
- Parents would measure & record local reaction rates for 3 days in a reaction diary (which they posted back to me)
- Data would be compared to determine redness, swelling, pain after injection for each needle size group

RESULTS: SWELLING POST 3RD DPT/HIB



REDNESS POST 3RD DPT/HIB

70 P = 0.04**60 23G 50** % of infants 25mm P = 0.0004needle **40** P = 0.0006 **25G** 30 16mm 20 needle 10 0 RR Day 1 Day 2 Day 3 6 hours **RR 0.45 RR 0.13** 0.66 (0.45, **RR 0.24** 0.99) (0.28, 0.72)(0.10, 0.60)(0.03, 0.56)

P = 0.0002

post-immunisation

TENDERNESS (PAIN) POST 3RD DPT/HIB



post-immunisation

For every three to five infants vaccinated with the longer rather than the shorter needle, one case of redness and one of swelling would be prevented

Diggle & Deeks BMJ 2000; 321: 931-933

Effect of needle length on incidence of local reactions to routine immunisation in infants aged 4 months: randomised controlled trial

Linda Diggle, Jonathan Deeks

Abstract

Objective To compare rates of local reactions associated with two needle sizes used to administer routine immunisations to infants. **Design** Randomised controlled trial.

Setting Routine immunisation clinics in eight general practices in Buckinghamshire.

Participants Healthy infants attending for third primary immunisation due at 16 weeks of age: 119 infants were recruited, and 110 diary cards were analysed.

Interventions Immunisation with 25 gauge, 16 mm, orange hub needle or 23 gauge, 25 mm, blue hub needle.

Main outcome measures Parental recordings of redness, swelling, and tenderness for three days after immunisation.

Results Rate of redness with the longer needle was initially two thirds the rate with the smaller needle (relative risk 0.66 (95% confidence interval 0.45 to 0.99), P = 0.04), and by the third day this had decreased to a seventh (relative risk 0.13 (0.03 to 0.56), P = 0.0006). Rate of swelling with the longer needle was initially about a third that with the smaller needle (relative risk 0.39 (0.23 to 0.67), P = 0.0002), and this difference remained for all three days. Rates of tenderness were also lower with the longer needle throughout follow up, but not significantly (relative risk 0.60 (0.29 to 1.25), P = 0.17).

Conclusions Use of 25 mm needles significantly reduced rates of local reaction to routine infant immunisation. On average, for every five infants vaccinated, use of the longer needle instead of the shorter needle would prevent one infant from

experiencing any local reaction. Vaccine manufacturers should review their policy of supplying the shorter needle in vaccine packs.

Introduction

As part of the UK childhood immunisation schedule, infants routinely receive diphtheria, pertussis, and tetanus (DPT) vaccine and Haemophilus influenzae type b (Hib) vaccine at 2, 3, and 4 months.¹ Nationally available guidelines advise practitioners to administer primary vaccines to infants by deep subcutaneous or intramuscular injection using either a 25 or 23 gauge needle but give no recommendation regarding needle length.1 The question of optimum needle length for infant immunisation has not previously been addressed in Britain, despite calls from nurses for evidence on which to base immunisation practice. We conducted a randomised controlled trial of the two needle sizes currently used by UK practitioners to determine whether needle size affects the incidence of redness, swelling, and tenderness.

Participants and methods

Participants

Eight of 11 general practices approached in Buckinghamshire agreed to participate in the study. Practice nurses recruited healthy infants attending routine immunisation clinics. Parents received written information about the study when attending for the second primary vaccination and were asked if they wished to participate when they returned for the third vaccination. The only exclusion criteria were those normally applicable to a child receiving primary immunisations.¹ Oxford Vaccine Group, University Department of Paediatrics, John Radcliffe Hospital, Oxford OX3 9DU Linda Diggle senior research nurse

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BMJ 2000;321:931-3

BUT UNANSWERED QUESTIONS REMAINED

1. Does the size of needle matter for local reactions at two & three (as well as four) months of age?

2. Is it the length or the gauge that makes a difference to the local reaction rates?

3. Does the size of needle make a difference to how well the vaccine protects the child?



2002: AWARDED NHS EXECUTIVE SOUTH-EAST RESEARCH & DEVELOPMENT PROJECT GRANT OF £138,000

BECTON DICKINSON PROVIDED AN UNRESTRICTED GRANT OF £10,000

EQUIVALENT TO AROUND £252,000 IN 2024

SECOND RCT TO COMPARE 3 NEEDLE GROUPS

- Blue wide long needle
 23G 25 mm (1-inch)
- 2. Orange narrow short25G 16 mm (5/8 inch)
- 3. Orange narrow long25G 25 mm (1-inch)



If Group 1 & Group 3 gave different results, then the difference had to be due to the needle gauge

Needle gauge diameters: Blue 23G = 0.6mm, Orange 25G = 0.5mm

MORE COMPLICATED RCT COMMENCED 2002

- Recruitment in similar way 696 infants
- Randomised to one of three needle groups to receive 2, 3 & 4-month injections with assigned needle size (DPT/Hib and MenC given in separate thighs)
- Parent completed reaction diary for 3 days post each set of injections
- Venous blood sample one month after 3rd injection (four study visits per child)
- Blood test was conducted in parental home (LA used)
- Research nurses employed solely to work on the study
- Also commenced PhD

LARGE RCT COMPARING LOCAL REACTIONS & IMMUNOGENICITY ACROSS THREE NEEDLE SIZES



*Blood draw at 28-42 days after 3rd dose DPT/Hib and Men C

LOCAL REACTION RATES AFTER 1ST DOSE DTWP/HIB (2 MONTHS)



LOCAL REACTION RATES AFTER 2ND DOSE (3 MONTHS)



LOCAL REACTION RATES AFTER 3RD DOSE (4 MONTHS)



SAME LENGTH, DIFFERENT GAUGE?

 There were no significant differences in incidence of local reactions



EVIDENCE SHOWED <u>SEVERE REACTIONS</u> MORE OFTEN WITH SHORTER NEEDLE

	Wide long	Narrow short	Narrow long
	(n=240)	(n=230)	(n=226)
Large local reaction			
contra-indicating receipt of further	1	10	0
whole-cell pertussis containing vaccine*			

 $\chi 2 = 7.94, df = 1, p=0.005$ *As defined by Department of Health. *Immunisation against infectious diseases*. London: HMSO, 1996

DID NEEDLE SIZE AFFECT PROTECTION?

 Longer needle ensured vaccine gave comparable, if not superior, protection



IN SUMMARY

- Needle size does matter (as the needle should be long enough to reach muscle)
- 25mm needle reduces local reaction rates in infants
- 25mm gives the same, if not better, level of protection as the shorter 16mm needle
- Gauge (diameter) makes <u>no</u> difference to reactions
- Best practice is to use 25mm for term infants
- Use clinical judgement for premature or LBW infants



BMJ, doi:10.1136/bmj.38906.704549.7C (published 4 August 2006)

RESEARCH

Effect of needle size on immunogenicity and reactogenicity of vaccines in infants: randomised controlled trial

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Use long needles to immunise infants

ts and to investigate whether the incidence of reedles of varving lengths and gauges.

ths of age, with follow-up to 5 months of age.



Long (25 mm) needles are best for immunising children aged 2, 3, and 4 months, say Diggle and Deeks (p 571). They randomised almost 700



Which needle for childhood vaccinations?

Long (25 mm) needles are best p 563, p571

We thank the participants; research nurses Karen Stone, Helen Layton, and Tessa Waterhouse for carrying out the study visits, administering immunisations, and collecting venepuncture samples; Shamim Shah-Gallardo for distraction of infants during venepuncture; general practices of Vale of Aylesbury and North East Oxfordshire primary care trusts who participated and welcomed us into their surgeries; Vale of Aylesbury and Oxfordshire child health computer departments for mailing of invitation letters to parents; Ray Borrow and team (Health Protection Agency Meningococcal Reference Unit, Manchester Royal Infirmary) for meningococcal C serum analyses; Armelle Marais (Sanofi Pasteur MSD) for organising shipment of samples, and William Bartlett and the Global Clinical Immunology Platform team, Sanofi Pasteur US for serum analyses of diphtheria; Carly Banner (Immunology Research Laboratory, Churchill Hospital, Oxford) for serum analyses of Haemophilus influenzae type b and tetanus; David Foxcroft, Lindsey Coombes, and Jane V Appleton (Oxford Brookes University) for PhD research supervision; Ly-Mee Yu (Centre for Statistics in Medicine) for running the programmes for verification of double data entry and help with presentation of results; Shirley Ashmore for administrative support; and students Sarah Hall and Paul Diggle for data entry

GREEN BOOK IMMUNISATION PROCEDURES CHAPTER 4 STATES:

Route of injection

Most vaccines should be given by intramuscular (IM) injection. Injections given intramuscularly, rather than deep subcutaneously, are less likely to cause local reactions (Diggle and Deeks, 2000; Mark *et al.*, 1999). Vaccines should not be given intravenously.

Injection technique

IM injections should be given with the needle at a 90° angle to the skin and the skin should be stretched, not bunched. Deep SC injections should be given with the needle at a 45° angle to the skin and the skin should be bunched, not

Choice of needle size

For IM and SC injections, the needle needs to be sufficiently long to ensure that the vaccine is injected into the muscle or deep into subcutaneous tissue. Studies have shown that the use of 25mm needles can reduce local vaccine reactogenicity (Diggle *et al.*, 2000, Diggle *et al.*, 2006). The width of the needle (gauge) may also need to be considered. A 23-gauge or 25-gauge needle is recommended for intramuscular administration of most vaccines (Plotkin and Orenstein, 2008). Mor deep SC injection site

Figure 4.2 Preferred site for intramuscular and deep subcutaneous injections in infants under one year of age

https://www.gov.uk/government/ collections/immunisation-againstinfectious-disease-the-greenbook

Immunisation procedures

For intramuscular injections in infants, children and adults, therefore, a 25mm 23G (blue) or 25mm 25G (orange) needle should be used. Only in pre-term or very small infants is a 16mm needle suitable for IM injection. In larger adults, a longer length (e.g. 38mm) may be required, and an individual assessment should be made (Poland *et al.*, 1997, Zuckerman, 2000).