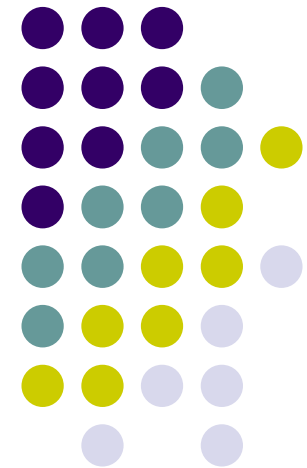
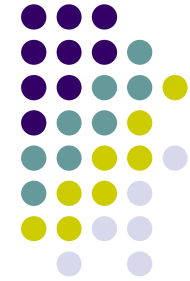


Use of lead shielding for adult chest CT

Dose measurements and
patient & radiographer
experiences



Previous published work



Doshi S, Negus I, Oduko J, Foetal radiation dose from CT pulmonary angiography in late pregnancy: a phantom study. Br J Radiol, 2008; 81: 653-658.

Kennedy E, Iball G, Brettle D, Investigation into the effects of lead shielding for foetal dose reduction in CT pulmonary angiography. Br J Radiol, 2007; 80: 631-638.

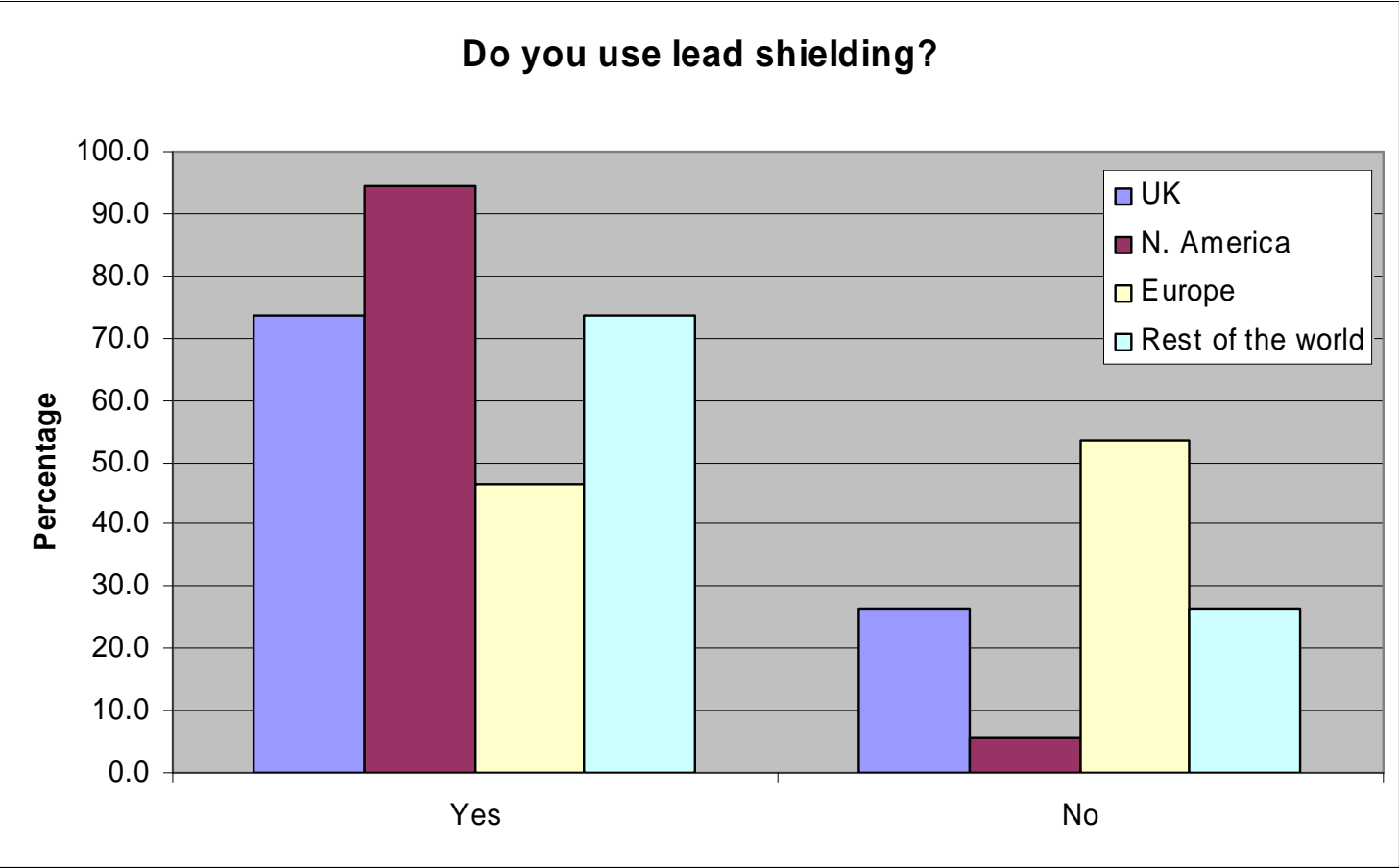
Iball G, Kennedy E, Brettle D, Modelling the effect of lead and other materials for shielding of the foetus in CT pulmonary angiography. Br J Radiol, 2008; 81: 499-503.



International Survey

- An online survey of CT Radiographers:
 - Do you use lead shielding during pregnancy?
 - Do you find it heavy or light?
 - How well does it fit the patient?
 - Do you have any work related back problems?
 - Do patients complain about the weight of the shielding?
- 390 completed responses (543 total)
 - 117 from Australia, 114 from UK, 110 from North America, 41 from Europe, 8 others
- Thank you for your assistance!

Do you use lead shielding?

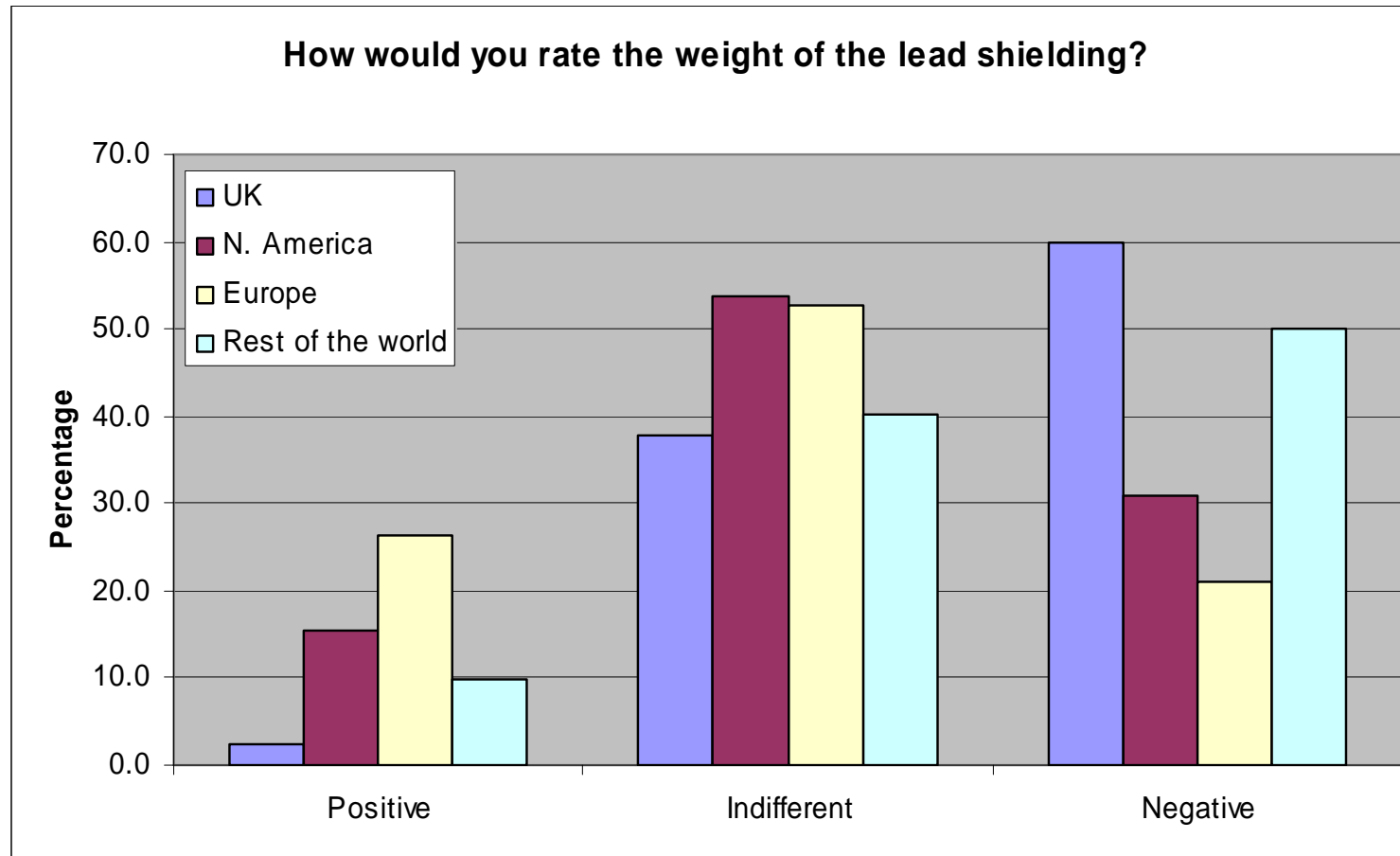
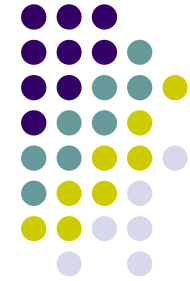




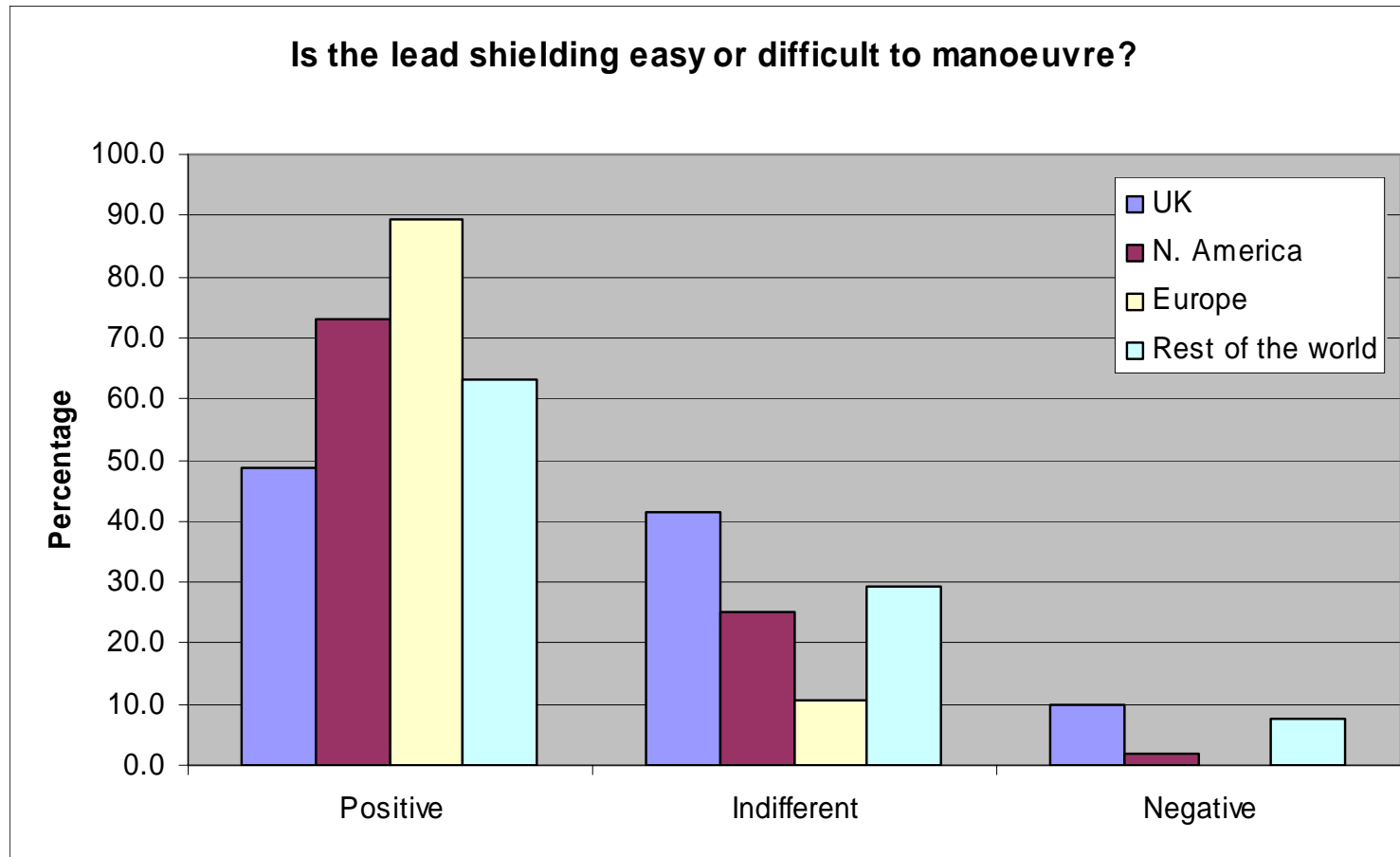
Use of shielding

Region	Using lead shielding (%)	Using shielding on both sides of patient (%)	Using shielding as per recommendations (%)
UK	73.7	90.1	66.4
North America	94.5	98.1	92.8
Europe	46.3	89.5	41.5
Rest of the world	73.6	88.2	64.9

Moving and handling



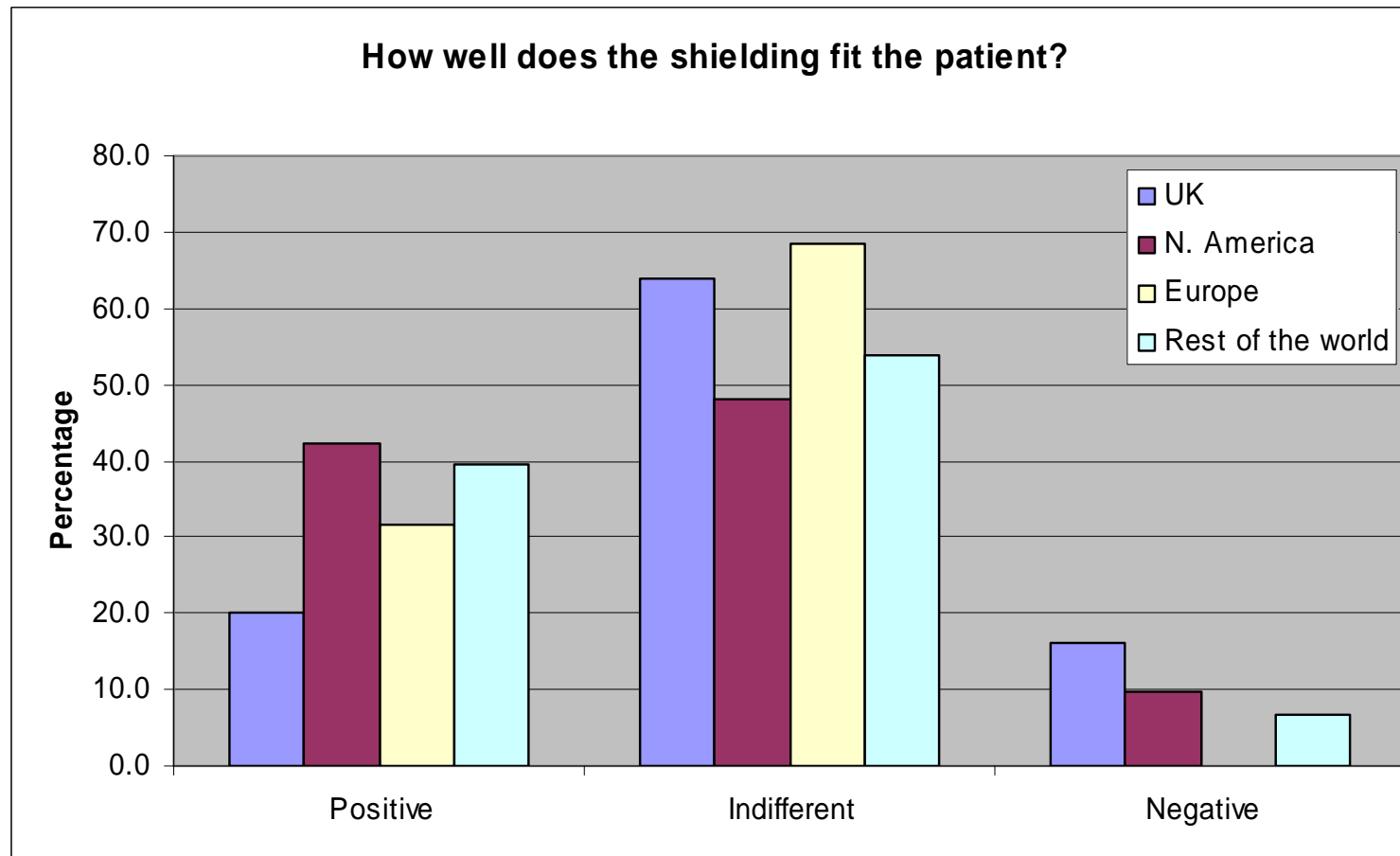
Moving and handling



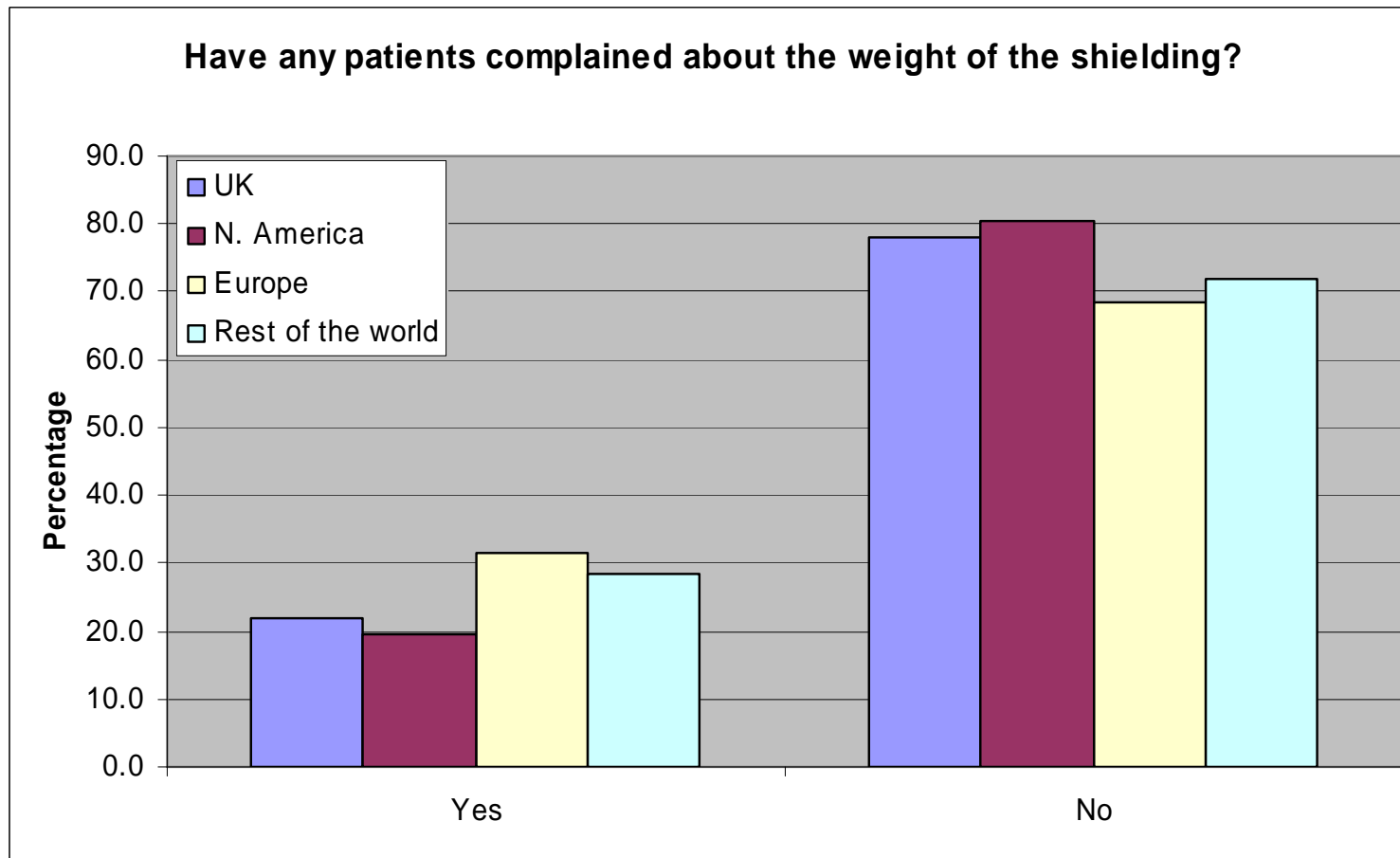
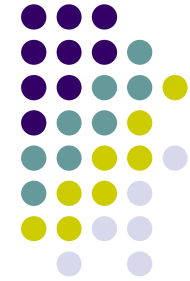
Radiographers back problems



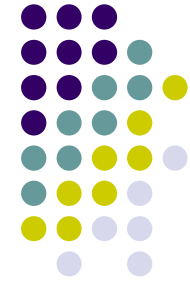
How well does the shielding fit?



Complaints about weight



Summary responses



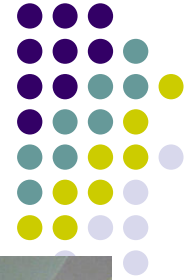
- “The lead shielding fit is more difficult closer to the end of the pregnancy, trying to get the lead to stay on the abdomen and not to slide into the anatomy to be covered is difficult.”
- “If the patient is very big I may have to use three aprons to completely circumvent the patient.”
- “It is difficult to eliminate the gap at the sides and sometimes an additional apron is used which increases the weight on the abdomen.”

The need for something new...

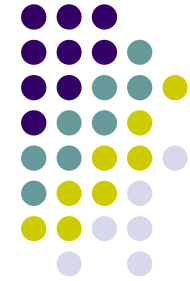


“Big patients are very difficult to get the shielding all the way around. There is nothing specifically designed for pregnant people.”

ShieldAll™



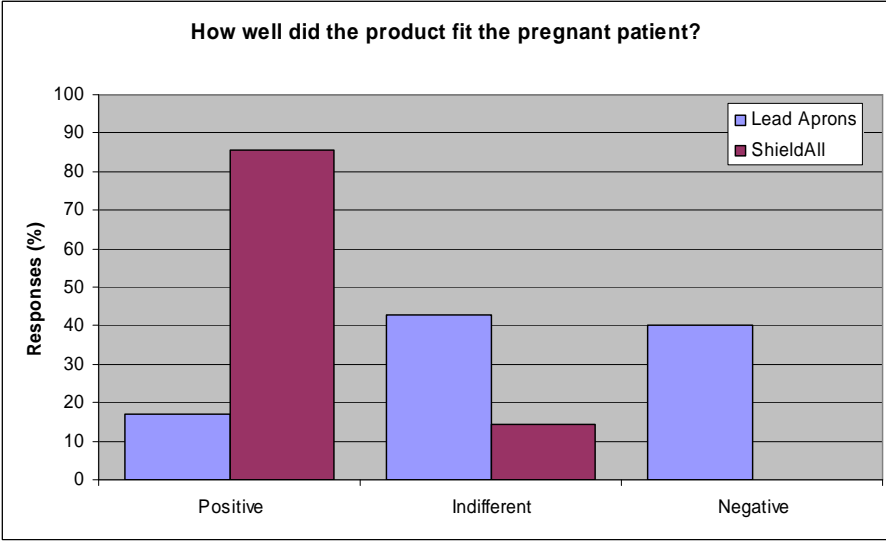
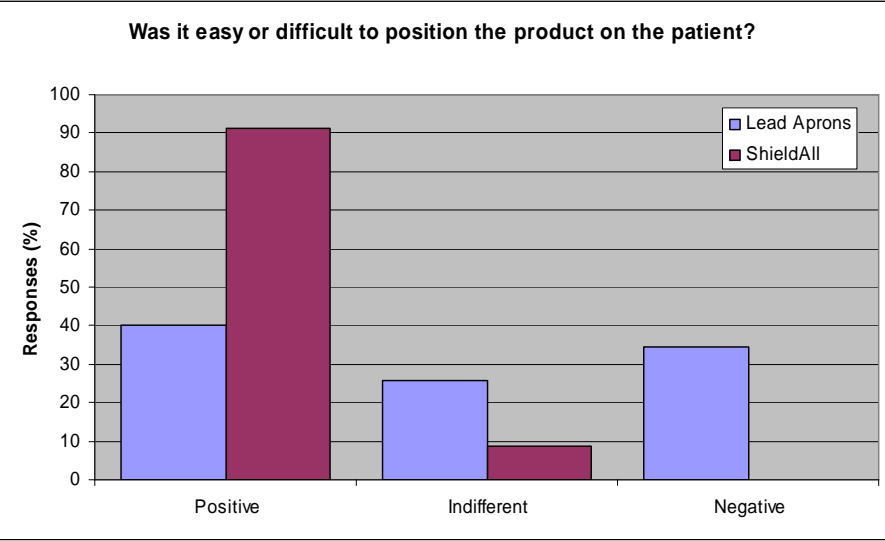
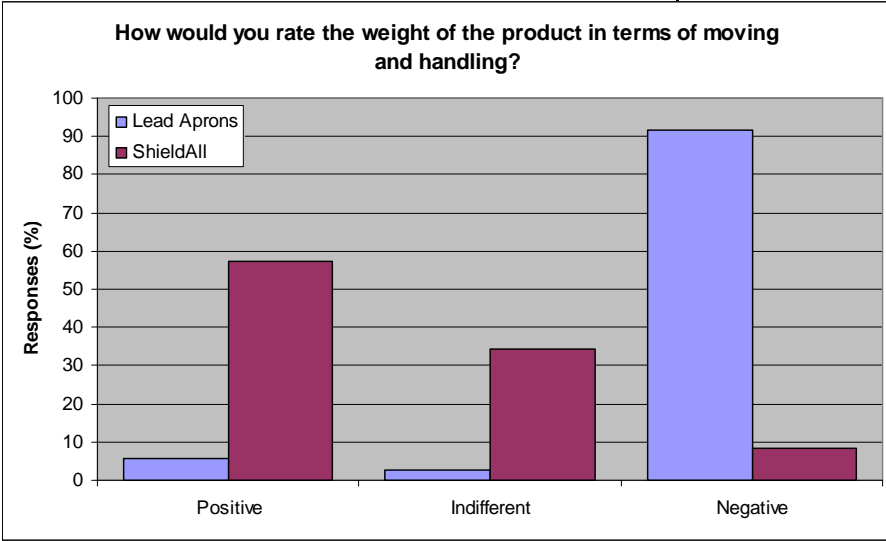
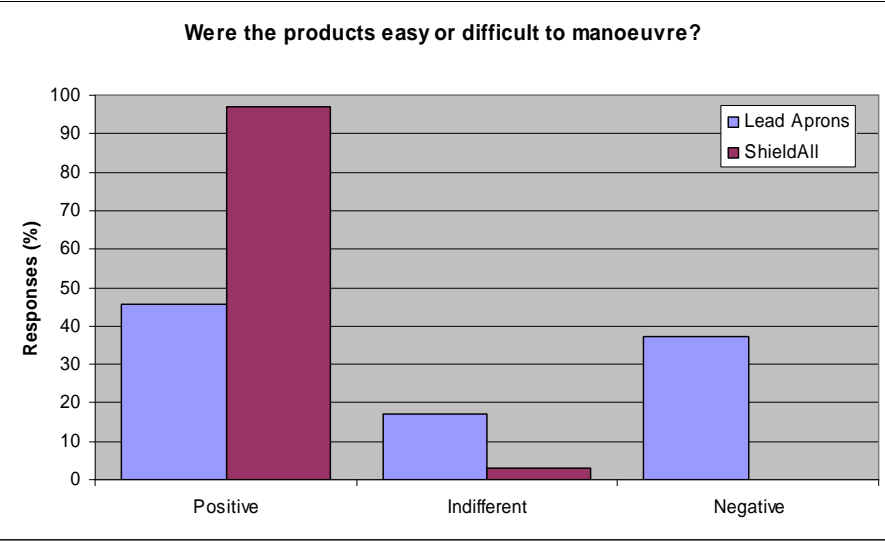
Comparative study



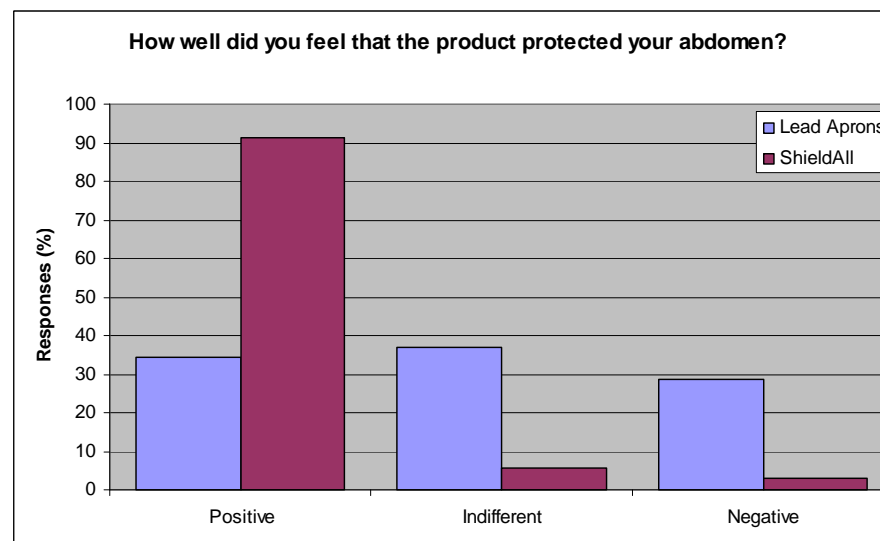
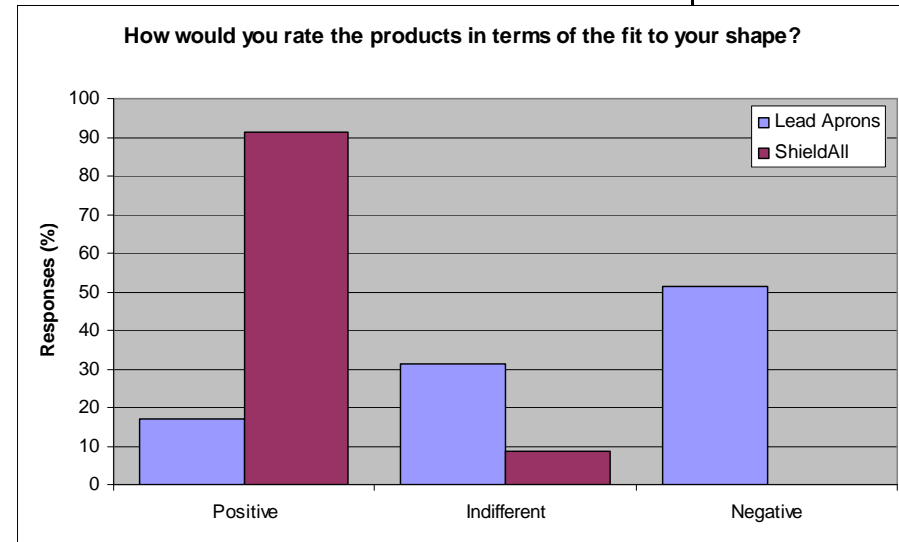
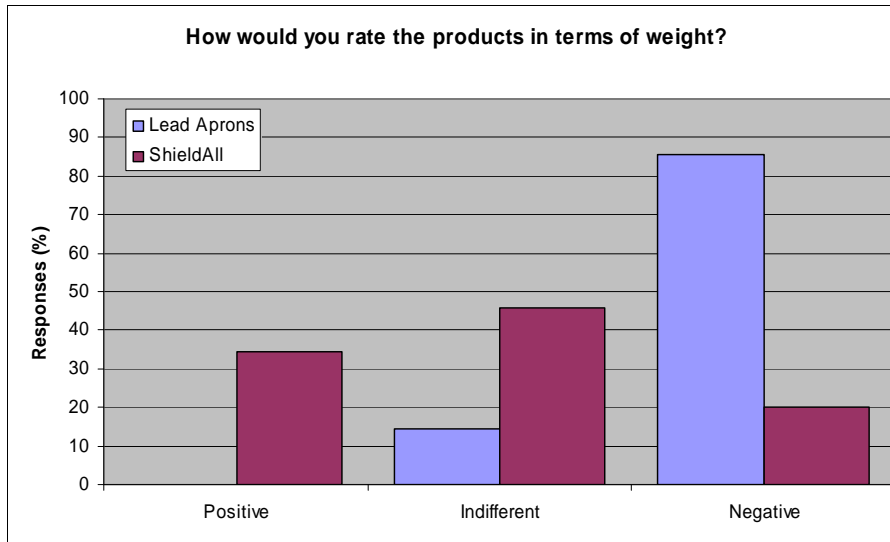
- 35 volunteers
 - 'Patient' & radiographer
- Simulated pregnancy
- Compare Pb aprons and ShieldAll
 - Weight
 - Manoeuvrability
 - Fit to patient shape
 - Perception of protection



Radiographer



Patient



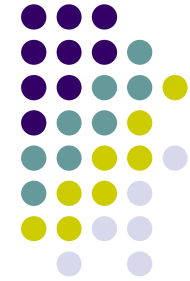


Comparative study - results

From the radiographer perspective			
	Positive	Indifferent	Negative
Lead aprons	27%	22%	51%
ShieldAll	83%	15%	2%

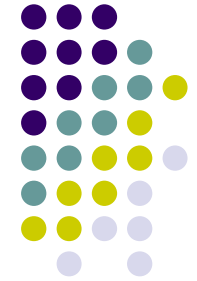
From the patient perspective			
	Positive	Indifferent	Negative
Lead aprons	17%	28%	55%
ShieldAll	72%	20%	8%

A volunteer's response



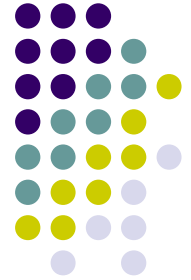
“The lead coat was very bulky and could maybe seem unprofessional and slap dash to a patient who is in late pregnancy with the added worries of having to have a CT scan, whereas the [ShieldAll] seemed more catered and suitable to the CT scan table and was much lighter and in my opinion would provide much more protection to the foetus.”

Focus groups: summary

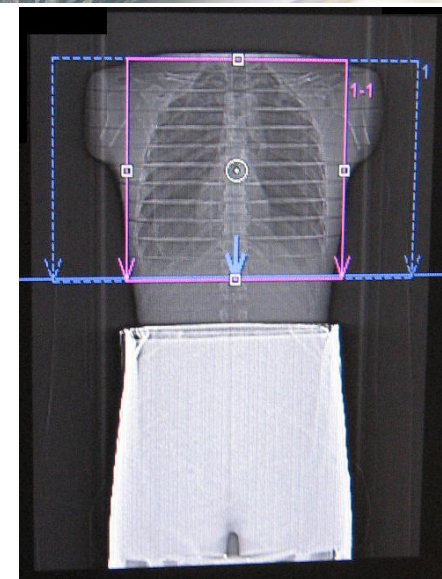


“... the [ShieldAll] was unanimously preferred over the lead coat, both from a patient perspective and an administering radiographer.”

Dose saving for non-pregnant patients



- Scanned chest of anthropomorphic male phantom
- Abdomen & pelvis contained TLDs for dose measurement
- Three sets of scans:
 - No lead
 - Lead aprons
 - ShieldAll

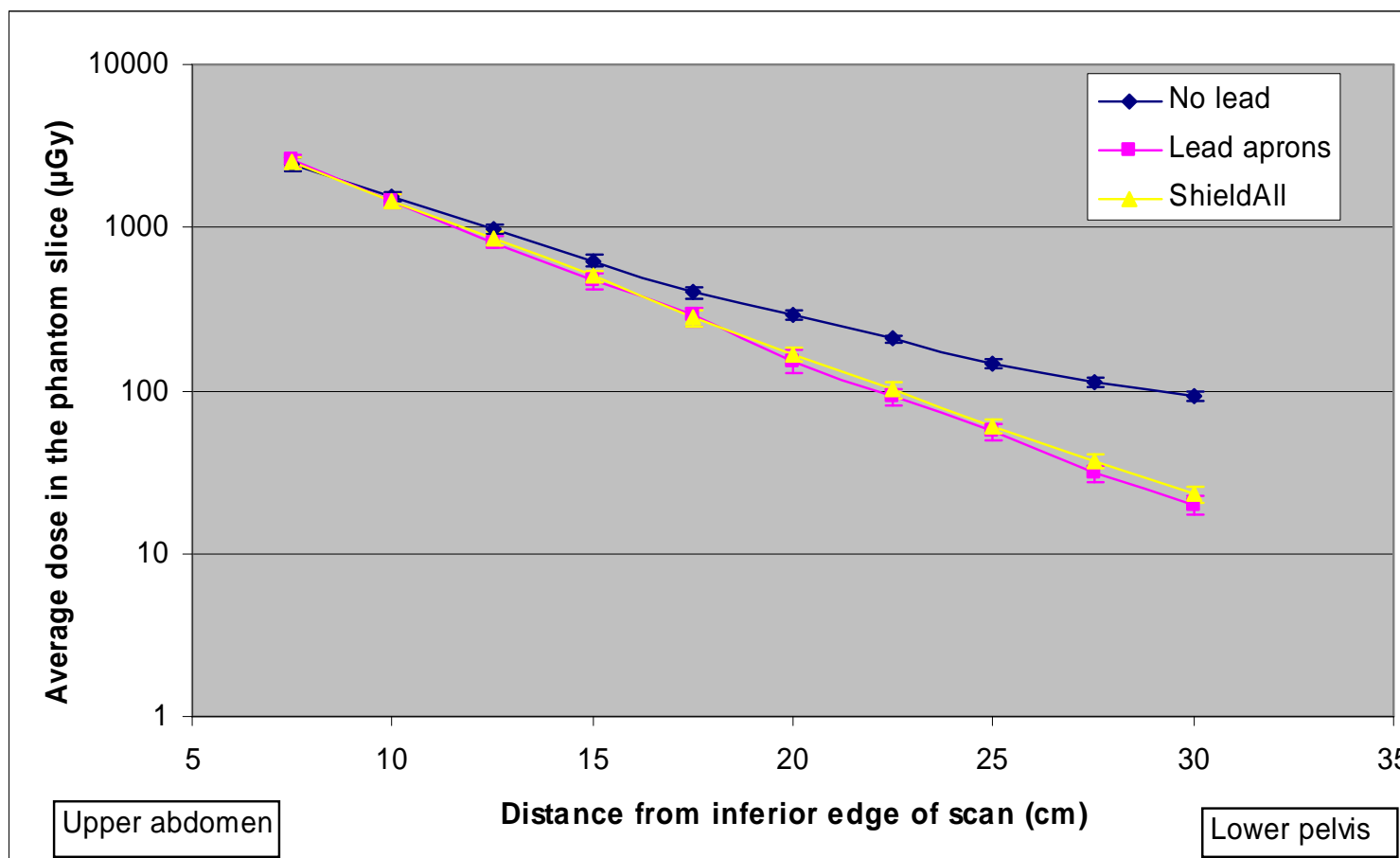




Dose calculations

- Calculated point doses and average dose per slice
- Match organ and dose measurement positions for shielded organs → organ doses
- Bone surface (skin & bone marrow)
 - Organ fraction per phantom slice
 - Bone surface dose per phantom slice
 - Weighted for percentage in shielded region

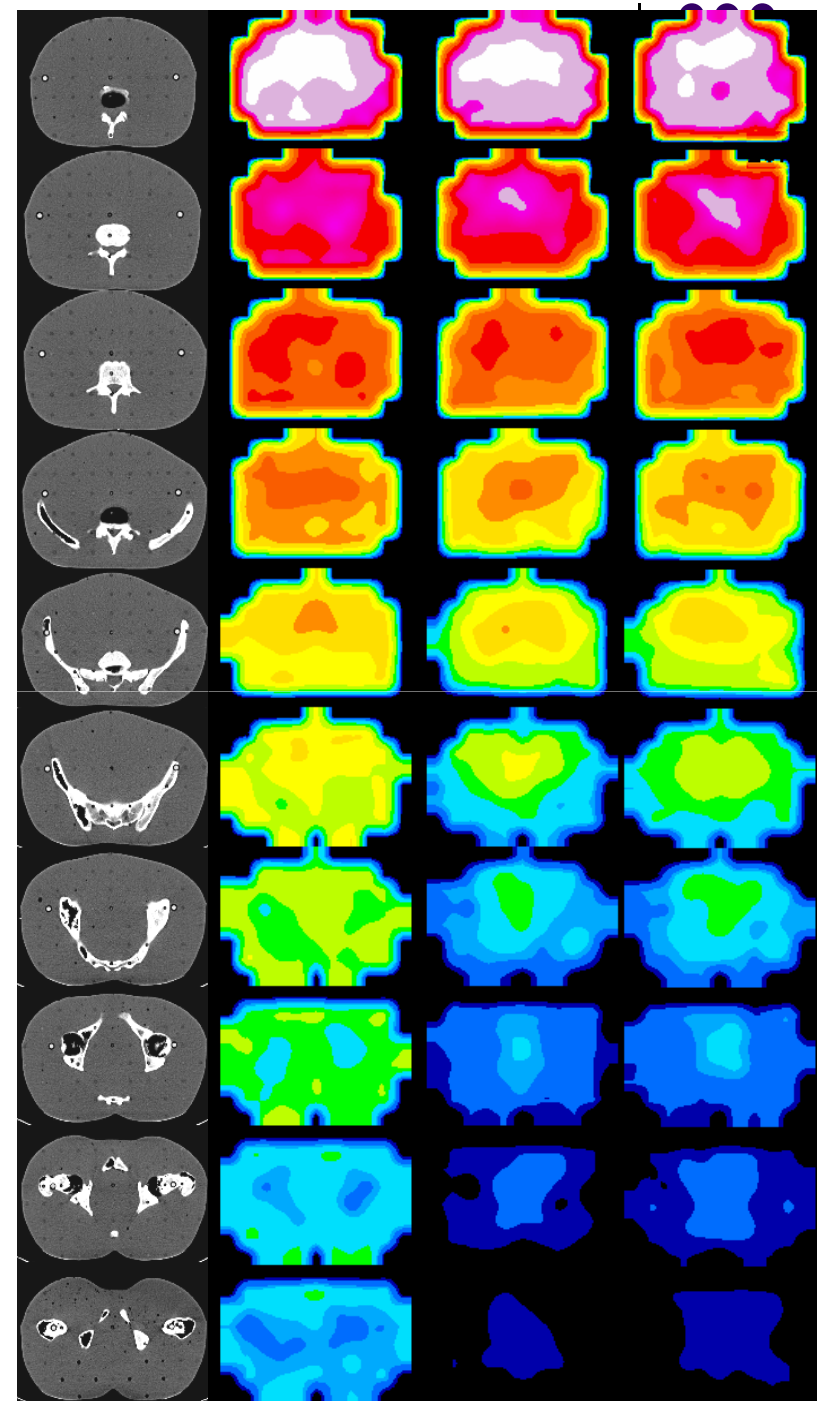
Average dose per slice



No statistically significant difference between lead aprons and ShieldAll data sets ($p=0.4990$)

Dose distributions

- No lead
- Lead aprons
- ShieldAll
 - Map of dose scattered outside scan volume
 - Dose savings greatest at periphery of phantom
 - Successfully eliminating external scatter





Organ dose savings

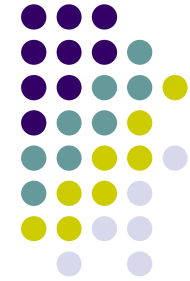
Organ/Tissue	Tissue weighting factor (ICRP 103)	Dose saving (%)
Bone Marrow (Red)	0.12	16.6
Bone Surface	0.01	9.5
Colon	0.12	33.2
Kidneys	Remainder	3.7
Lymph Nodes	Remainder	35.0
Muscle	Remainder	35.0
Ovaries	0.08	24.9
Prostate	Remainder	59.0
Skin Surface	0.01	9.3
Small Intestine	Remainder	3.8
Testes	0.08	71.7
Urinary Bladder	0.04	40.9
Uterus	Remainder	35.4

Dose savings summary



- Up to 72% reduction in dose to specific organs
- 4% reduction in effective dose
 - Over and above dose savings from protocol optimisation (e.g. lowering mA)
- Large reduction in collective dose
- Thus large reduction in collective risk

USA case study



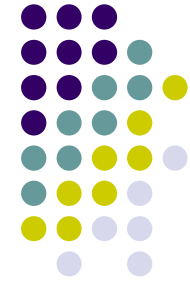
- CT delivers ~50% of medical collective effective dose (~70 million scans in 2007)

- ~4100 cancers/year due to chest CT

(Berrington de Gonzalez A et al, Projected Cancer Risks From Computed Tomographic Scans Performed in the United States in 2007. Arch Intern Med, 2009; 169 (22): 2071-2077.)

- Reduced to ~3900 by use of shielding

Conclusions



- Lead shielding still not universally used for pregnant patients
- ShieldAll approved by ‘pregnant patients’ and radiographers
- Yields significant organ, effective and collective dose savings
 - Over and above conventional optimisation
 - Associated reduction in collective risk
- Recommend use on all patients undergoing CT scans, especially pregnant patients and paediatrics

Acknowledgments



This study was funded by Yorkshire Forward and Medipex Ltd as part of the Yorkshire Enterprise Fellowship

