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The principles of good manual handling: Achieving a consensus

Prepared by the
Institute of Occupational Medicine
for the Health and Safety Executive 2003

RESEARCH REPORT 097

The principles of good manual handling: Achieving a consensus

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This report presents the outcome of an exercise carried out to establish scientifically-based principles for manual handling training, both for conventional (two-handed, symmetrical) lifting and for 'non-standard' lifting, where the conventional technique is inapplicable.

A core feature of the study was a 'Delphi' exercise, consulting with experts in a variety of disciplines relevant to manual handling training. A total of 37 national and international experts contributed in some way to this exercise. On the basis of their comments, a series of principles was identified relating to conventional lifting. Presented in the report, these either supplement or refine those presented in the current version of the Guidelines to the Regulations, L23 (HSE, 1998). For each of the eleven principles proposed, explanatory sub-text is suggested, mirroring the current style in L23.

The consultation process over the non-standard lifting situations was less satisfactory with generally less consensus over the best advice. In order therefore to provide the basis for scientifically-supported principles in non-standard situations a review of the literature was conducted. This examined the published literature relevant to the different lifting scenarios. The report uses the findings from this to present guidelines for each of the situations identified. These guidelines are intended to provide practical guidance to be applied in situations where conventional two-handed symmetrical lifting is not possible. For example, the scientific literature would suggest that, when lifting large bulky loads, keeping the load close to the body is more important than bending the knees. As well as this lifting and handling situation, guidance was provided on one-handed lifting; large, flat vertical loads; lifting from a container; lifting in limited headroom; lifting whilst seated; lifting light loads from low down; and carrying loads.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

HSE BOOKS

First published 2003

ISBN 0 7176 2179 0

EXECUTIVE SUMMARY

The Manual Handling Operations Regulations 1992 place requirements on employers to avoid hazardous manual handling activities where reasonably practicable to do so. Where this is not practicable they must institute a series of measures intended to remove or reduce the risk of injury associated with manual handling tasks. These measures strongly reflect an ergonomics approach to risk assessment and reduction, seeking to avoid the risk of injury by improving the design of the workplace and the working environment.

Traditionally, employers have relied on providing training in correct manual handling techniques as a means of controlling such risks. Although it is now recognised that this is not the best approach, situations will continue to arise where some reliance must be placed on the use of correct techniques. This may be as an adjunct to design changes or when the handling activity is not amenable to change.

Handling training in the past has usually focused on what is often referred to as two-handed, symmetrical lifting. However, many instances can be identified where such training is inapplicable or inappropriate.

This study examined two issues. The first of these concerned the scientific principles underlying conventional two-handed lifting training, considering whether or not they still remained valid; whether they required modifying in any way in the light of current scientific knowledge; and whether any additional principles could be identified. The second considered other forms of lifting (e.g. one-handed lifting) examining the relevance of these same principles and determining scientifically-based priorities where aspects of the lifting task meant that not all principles could be adhered to.

Focus groups were held with manual handling trainers and others concerned with the day-to-day control of manual handling hazards. These identified handling activities where conventional lifting training was inappropriate. At the same time, the scientific literature was scanned and summarised to inform discussions on handling principles.

A core feature of the study was then a ‘Delphi’ exercise, consulting with experts in a variety of disciplines relevant to manual handling training. This sought to establish a consensus on the basic physical and behavioural elements of good handling principles, both for conventional two-handed symmetrical lifting and for other forms of lifting. Further consultations were then carried out with manual handling trainers in order to refine the manner of expression of the principles.

A total of 37 national and international experts contributed in some way to the Delphi exercise. On the basis of their comments, a series of principles were identified relating to conventional lifting. These either supplemented or refined those presented in the current version of the Guidelines to the Regulations, L23 (HSE, 1998). The wording of some of these was refined to reflect the outcome of discussions with experienced trainers. In addition, one provisional new principle, that of warming-up prior to carrying out handling activities, was dropped because no support for the value of warming up could be found from the scientific literature (including the sports science literature relating to athletic or sporting performance). The principles eventually proposed were:

- Think before you lift;
- Keep the load close to your waist;
- Adopt a stable position;

- Ensure a good hold on the load;
- At the start of the lift, moderate flexion (slight bending) of the back, hips and knees is preferable to fully flexing the back (stooping) or the hips and knees (squatting);
- Don't flex your spine any further as you lift;
- Avoid twisting the trunk or leaning sideways, especially while the back is bent;
- Keep you head up when handling;
- Move smoothly;
- Don't lift more than you can easily manage;
- Put down then adjust.

For each of these, explanatory sub-text is proposed in the report, mirroring the current style in L23. Although there were some differences of opinion as to how best to express these principles, some of which related to the application of the principles (technique) rather than the principle itself, there was a broad consensus of agreement for the underlying principles. For example, some preferred the more scientifically precise 'minimise the horizontal distance between the lower back of the handler and the centre of gravity of the load throughout the manual handling operation' to the wording eventually selected of 'keep the load close to your waist'.

The consultation process over the non-standard lifting situations was less satisfactory with generally less consensus over the best advice. In part this appeared to be due to differences in interpretation of what was wanted.

Some responders suggested that all the principles were important and should be adhered to 'as much as possible'. Whilst undoubtedly correct this failed to reflect the rationale behind the exercise in that it was not possible to follow all of the principles. It was not clear whether these responses were due to a misunderstanding of the purpose of the exercise or a reluctance to express an opinion.

In order therefore to provide the basis for scientifically supported principles in non-standard situations a further review of the literature was conducted. This examined the published literature relevant to the different lifting scenarios, using the findings to present guidelines for each of the situations identified. They therefore provide practical guidance to be applied in situations where conventional two-handed symmetrical lifting is not possible. For example, the scientific literature would suggest that, when lifting large bulky loads, keeping the load close to the body is more important than bending the knees. As well as this lifting and handling situation, guidance was provided on one-handed lifting; large, flat vertical loads; lifting from a container; lifting in limited headroom; lifting whilst seated; lifting light loads from low down; and carrying loads.

CONTENTS

1. INTRODUCTION

Potentially hazardous manual handling tasks are undertaken by many employees on a daily basis. As a result, the Health and Safety Executive (HSE) have identified manual handling as an area of concern. The main piece of legislation relating to manual handling is the Manual Handling Operations Regulations 1992 (MHORs) and their accompanying guidance (L23, 1992 and 1998). These rightly place the emphasis on reducing *at source* the risks from manual handling. To achieve this, the Regulations set out a clear hierarchy of measures:

1. avoid hazardous manual operations so far as reasonably practical by redesigning the task to eliminate the need to move the load, or alternatively by automating or mechanising the process;
2. make a suitable and sufficient assessment of any hazardous manual handling operation that cannot be avoided; and
3. reduce the risk of injury so far as reasonably practical by optimising the design of the manual handling operations.

The assessment and risk reduction steps use the ergonomic approach, where a range of relevant factors, including the nature of the task, the load, the working environment and individual capability are considered to ensure that the workplace and the way the tasks are carried out are acceptable to the range of potential handlers.

Even if this approach is taken, the safe execution of a manual handling operation may still rely on application of correct handling techniques. In addition there are still unavoidable situations where manual handling will occur, as it may not be possible to alter the load or the workplace (e.g. handling patients in an emergency situation). Although not a substitute for using the ergonomic approach and designing a safe system of work, good handling technique training can complement the main risk reduction strategy associated with manual handling of the loads. The importance of co-ordinating workplace design and handling training has long been recognised as vital in reducing handling injuries. Graveling *et al* (1985) summarised the need to ensure both that the workplace was designed in such a way as to allow the application of good handling principles and that the workforce was aware of what constituted these good principles.

However, it is well recognised that any training relies on the correct principles being outlined, understood and applied by handlers. There are many concerns about the suitability of training, and much debate has taken place concerning its effectiveness. However, it is recognised that training can provide a useful way of helping handlers to identify the risks in the handling task, and to reduce those risks, through appropriate planning of the handling activity, and handling techniques.

The guidance that accompanies the Manual Handling Operations Regulations (L23) outlines the handling principles that relate to a symmetrical two-handed lift. A need was identified to ensure that these principles are incorporated into any training. In addition, while these principles are useful, there was concern that they did not relate to all handling situations, and that there was a lack of clear guidance on appropriate handling techniques for these other 'non-standard' situations. It was to meet these needs that this research was commissioned.

1.1 DISTINCTION BETWEEN 'PRINCIPLES' AND 'TECHNIQUES'

It is important for the subsequent discussion to be clear on the difference between manual handling 'principles' and 'techniques'. Principles can be seen as the safest way for the body to move while technique can be seen as how to obtain these postures or movements. It is recognised that many different lifting techniques are currently taught (e.g. kinetic lifting, neuromuscular lifting etc). It was not proposed to examine these techniques, rather to concentrate on the principles that underlie them. This distinction between principles and techniques was made clear to all those involved in the research.

1.2 MANUAL HANDLING PRINCIPLES CURRENTLY OUTLINED IN L23

The guidance document L23 currently presents the principles of performing a basic two-handed symmetrical lift (paragraph 174). The important principles and their explanatory points covered are:

1. Stop and think (plan the lift)

2. Place the feet
   - Have the feet apart, giving a balanced and stable base for lifting.
   - Have the leading leg as far forward as is comfortable.

3. Adopt a good posture
   - Bend the knees so that the hands when grasping the load are as nearly level with the waist as possible; but do not kneel or over-flex the knees.
   - Keep the back straight, maintaining its natural curves (tucking in the chin while gripping the load helps).
   - Lean forward a little over the load if necessary to get a good grip.
   - Keep the shoulders level and facing in the same direction as the hips.

4. Get a firm and secure grip
   - Try to keep the arms within the boundary formed by the legs.
   - The optimum grip may vary, but it should be secure.
   - If you vary the grip while lifting, do this as smoothly as possible.

5. Don't jerk
   - Carry out the lifting movement smoothly, raising the chin as the lift begins, keeping control of the load.

6. Move the feet
   - Don't twist the trunk when turning to the side.

7. Keep close to the load
   - Keep the load close to the trunk for as long as possible.
   - Keep the heaviest side of the load next to the trunk.
   - Slide the load towards you before attempting to lift it.

8. Put the load down, then adjust its position

These are the principles that are presented concerning good handling technique. Other principles are also outlined in L23 and distributed within the text. A summary of the main points relating to handling principles contained within L23 (in paragraphs 120 – 172) is shown below.

- When handling at or near floor level, preferably use handling techniques which make use of the relatively strong leg muscles rather than those of the back, provided the load is small enough to be held close to the trunk. Bear in mind however that such techniques impose heavy forces on the knees and hip joints which must carry the weight of the load and the weight of the rest of the body.
- Place feet beneath or adjacent to the load.

- Move close to the load before beginning the manual handling operation.
- Hold the load (as) close to the body (as possible) during the manual handling operation.
- Address the load squarely before beginning the manual handling operation.
- Preferably face the intended direction of movement before beginning the manual handling operation.
- If possible, avoid lifting loads from the floor when seated.
- If possible, avoid twisting, stooping or stretching when handling.
- Where a load is bulky rather than heavy it may be easier to carry it at the side of the body if it has suitable handholds, or if slings or other devices can be provided.

1.3 SITUATIONS WHERE THESE PRINCIPLES CANNOT BE APPLIED

It is well recognised that in many occupational situations, circumstances arise in which these principles cannot be applied. Limitations on the correct handling approach arise broadly under three headings;

1) The system of work or tasks;
e.g. repetitive one-handed lifting of small objects such as bricks.

2) Characteristics of the load;
e.g. loads that may harm the handler (e.g. hot, liquid) cannot be held close to the body.

3) Workplace constraints;
e.g. working with limited headroom (e.g. in a roof or loft space), or in kneeling or lying postures.

1.4 GAPS IN CURRENT GUIDANCE IN L23

It is clear from the above that there are some gaps in the guidance currently contained within L23, particularly where it is not possible to perform two-handed symmetrical lifting. No numerical guideline data are available in the L23 guidance on the effects on an individual's lifting capacity of lifting with one hand. It is widely accepted that a balanced lighter load held in each hand (e.g. carrying two balanced shopping bags) is less onerous on the musculoskeletal system than one heavier asymmetric load, but at what weight does an asymmetric load create excessive strain on the body? What combination of balanced loads is acceptable? Should a load be carried in front of the body with both hands or at the side with one? What are the recommended carrying capacities when carrying a load on the back and what is the optimum carrying style? Is the guideline figure of 20 kg for men between shoulder and knuckle height, held close to the body, acceptable for loads positioned behind the vertebral column rather than in front?

Gaps in handling techniques outlined in L23 are not only limited to lifting but also other manual handling activities such as carrying. There is a need for L23 to contain guidance for handling in these situations. The current guidance on carrying in L23 (HSE, 1998) states that, if the load is held against the body using both hands, similar guideline figures as those given in the Regulations for lifting apply for carrying distances of about 10m without resting. If the load can be carried securely on the shoulder without having to first lift (e.g. when unloading a sack from a lorry bed) it could be interpreted that the guideline figures can be applied to carrying distances in excess of 10m.

Guidance is needed to establish a hierarchy of points of good manual handling principles. For example, is keeping the load close to the body more important than maintaining correct lumbar lordosis and an erect spine? How do you minimize the risk if you cannot lift close to the body? What is an individual's lifting capacity if handling is carried out while kneeling or lying on the back and how are such lifts best performed?

Although it is also thought that guidance is needed on appropriate principles for pushing and pulling and guiding a load, it was decided – in discussion with the project officers – that the proposed research should be limited to the principles of lifting and carrying.

The project aimed to identify the practical circumstances in which conventionally accepted 'correct' handling techniques cannot be applied (and the need for manual handling cannot easily be designed out); to establish a research database from the literature against which such problems could be evaluated; and to achieve informed consensus on the basic physical and behavioural principles of good handling which can be used to provide practical solutions where current advice is inadequate (or possibly incorrect).

The focus of the research was the principles of good handling. However, it was recognised that these cannot be specified without reference to factors about the load, task, work environment and individual that will affect whether these principles can be applied. For example, the presence of handles will affect the grip that can be used when handling an item. Where appropriate, these factors were considered, and guidance on these in relation to handling were covered by the research. In addition, it was clear that providing handling training is only one part of the approach to addressing manual handling issues. As clearly specified in the guidance to the Manual Handling Operations Regulations (L23), avoidance of hazardous manual handling, and then ways of reducing the risk of injury through re-designing the load, task or environment should be the primary focus for addressing these problems. Once these have been addressed, it may be appropriate to provide some manual handling training based on appropriate principles.

It was recognized that the handling of live loads presented additional, different issues to handling non-live loads. Most obviously the psychosocial interaction between the handler and the load becomes an important part of the handling activity, and the co-operation or lack of it from the live 'load' significantly influences the effect on the handler. Considerable work has been done to produce guidance on handling live loads, and handling techniques have been addressed in other publications (e.g. Fletcher et al, 1998). It is thought that there may be principles outlined in these which can be applied successfully to the handling of non-live loads. Therefore the research included consultation with those who work in these sectors, to establish what principles are recommended. It is known that there have been changes over the years in the techniques that are recommended, particularly in the healthcare sector when handling patients. It was thought that there would be benefit in transferring accepted principles from this sector to a wider industrial application (when the load is not necessarily live).

2. AIMS AND OBJECTIVES

The overall aims of the proposed research were to identify where current advice on the principles of correct manual handling in L23 was inadequate or inapplicable and to provide supplementary advice to counteract those inadequacies.

To meet these aims, five specific objectives were identified:

1. To consult with manual handling trainers, industry safety practitioners, and other networks of professionals involved with training in manual handling and the day-to-day control of manual handling hazards, regarding the gaps in current advice on the principles of manual handling;

2. To overview published scientific literature on biomechanics and other relevant disciplines to inform debate as to the suitability of alternative or additional advice on manual handling techniques; to provide an overview of the manual handling principles currently being taught through some training courses; and to overview video training material to identify principles currently being taught;

3. To consult with scientific experts in relevant disciplines, through a 'Delphi' exercise, to establish an informed consensus on the basic physical and behavioural elements of good handling principles considered appropriate to meet the shortcomings identified by those involved in manual handling; and to develop, from this consensus agreed principles for handling in these non-standard situations;

4. To further consult with manual handling trainers and those who may teach these principles, concerning the suitability of the guidance produced; and

5. To make the results of this consensus available in a form suitable to be used to improve the advice already given in the HSE Guidance to the MHOR 1992 (L23) (HSE 1998) and other relevant publications.

It was intended that the research would result in scientifically valid guidance on practical manual handling problems to which conventional handling principles do not provide a solution.

3. OVERVIEW OF WORK

To meet these aims, the research was undertaken in four phases.

Stage one
Initially, a series of focus group meetings were held with health and safety experts and manual handling training providers to identify the gaps in the current guidance, and to identify where further clarity was needed in terms of the principles that should be applied when undertaking manual handling. This is described in Chapter 4.

Stage two
The second phase (Chapter 5) was to conduct an overview of the literature in order to obtain material that would form the basis of the discussion at the Delphi consensus forming exercise. In addition, a selection of manual handling training videos were viewed and the contents documented during this phase of the research.

Stage three
The Delphi exercise was then conducted as the third stage of the research (described in Chapter 6). This involved bringing together a group of experts in biomechanics, ergonomics and manual handling (including physiotherapists and those involved in manual handling training) to participate in a one day meeting. The aim of this exercise was to obtain a consensus on the principles that can be applied when manual handling. This discussion was informed by the information obtained in the first two stages.

Stage four
The final stage (Chapter 7) was to consult with health and safety practitioners and manual handling trainers as to the interpretation of the agreed principles and their application to the handling situations they encounter, or the training that they provide.

Following these activities, it became apparent that although the consultative exercises had been helpful in reviewing and refining current advice regarding conventional two-handed symmetrical lifting, the opinions presented concerning other lifting situations were less conclusive. The collective advice was to reaffirm the relevance of the same principles as established for two-handed symmetrical lifting whilst recognising that it was not always possible to conform to these. Little or no substantial guidance was available from these exercises as to which principles were most important and should therefore be adhered to, possibly at the expense of others. Consequently, a further overview of the research literature was conducted. The purpose of this was to fill this gap, to prioritise the principles in given handling situations and therefore to provide the basis for selection of handling techniques that were applicable to these 'non-standard' lifting situations. The results of this overview are presented in Chapter 8.

The set of agreed principles for manual handling, together with a summary of priorities for non-standard handling operations is presented in Chapter 9.

4. FOCUS GROUPS

4.1 INTRODUCTION

In order to identify the needs of training providers and those working in industry for further guidance on appropriate principles, a series of workshops and focus groups were held. Delegates to these were able to identify and discuss the situations they were encountering where it was not possible to apply the existing L23 guidance.

4.2 METHODS

A series of eight workshops were held with relevant organisations and groups over a four month period (March to June 2001). These meetings were set up through contacts with appropriate groups. A variety of different professionals were included in these discussions in order to encompass as wide a range of views as possible. Some of the meetings were set up specifically for the research; at others, time within a regular meeting was allocated for the focus group. A summary of the focus groups held, and approximate number of delegates attending is shown in Table 4.1.

Table 4.1 Focus Group details

Organisation	**Date of meeting**	**Location**	**Meeting type**	**Approx no. attending**	**Delegates' backgrounds / expertise**
Lothian Occupational Health and Safety Association	20.3.01	Edinburgh	Monthly	5	Health and safety experts
National Back Exchange, regional group representatives	26.3.01	London	Bi-annual	30	Manual handling co-ordinators, and training providers
The Ergonomics Society	11.4.01	Cirencester	Annual conference	30	Ergonomists, physiotherapists, occupational therapists
Public meetings, advertised in the RoSPA magazine and through National Back Exchange	2.5.01 (am)	London	Public	5 – non live load handling	Ergonomists, health and safety experts
	2.5.01 (pm)	London	Public	5 – patient handling	
Association of Chartered Physiotherapists in Occupational Health	18.5.01	Edinburgh	Annual conference	75	Physiotherapists
Manual Handling Co-ordinator's Forum	1.6.01	Monklands	Bi-annual meeting	30	Manual handling co-ordinators
Institute of Occupational Safety and Health	14.6.01	Edinburgh	Monthly	30	Health and safety experts

Each focus group lasted between 1.25 hours and 1.50 hours. During that time, the background to the research and a summary of the principles contained within L23 were presented by an IOM ergonomist. A sheet summarising the research and questions to be asked was given to all delegates. The questions to be considered in the focus groups were outlined. Delegates were asked to consider particularly the following questions:

- *What loads and situations are you aware of within your work environment where the principles in L23 cannot be applied? If possible, please give specific examples.*

- *What principles do you teach for handling these loads or in these situations?*

Following this initial introduction, delegates were asked to discuss these issues. Where meetings were attended by a large number, delegates broke into small groups (approximately 6-8 people) to discuss the issues. About 30 minutes was allowed for these discussions; during that time the IOM ergonomists moved between the groups and facilitated discussions where required. One delegate from each group was nominated as spokesperson for the group to feedback at the end of the discussion period. The main outcomes were summarised at the end of the meetings.

Telephone discussions were held with a number of individuals who were not able to attend the meetings but had expressed an interest in the research. These included Trade Union representatives.

4.3 SUMMARY OF SITUATIONS RAISED BY DELEGATES

Live loads

The issues raised covered handling both animals and people in both planned and emergency situations. There were many scenarios mentioned including: police dog handlers - lifting dog over an obstacle such as a fence when chasing a suspect; treating a patient within their own home where it was not possible to alter the layout; emergency situations such as dealing with a collapsed person; and prison officers dealing with an aggressive inmate who does not want to be moved.

Handling above shoulder height or below knee height

There were many examples given where a person may need to handle at an awkward height. Examples included stacking and unloading shelves in a variety of situations including parts stores (where smaller but heavier items are stored on the top shelf and no mechanical lifting aid is available); and supermarkets (where shelves may also be angled to display goods).

Handling at below knee height occurs in many situations. Examples given included bags of money being lifted from a safe situated on the ground.

Solutions to many of these problems could be achieved through better workplace design.

Handling over an uneven surface

Many examples were given of the difficulties of handling items up stairs, particularly for delivery of goods to people's homes, e.g. white goods, baths, boilers, furniture etc. This is particularly difficult in some old buildings that have narrow or winding stairs. Other examples of an uneven surface included: people working up a ladder and handling a tool bag or supplies; and lifting a body or sampling equipment out of the water, where the boat deck may tilt as the handler leans over the edge.

Working in confined spaces

In other situations, the amount of space for the handler to work within may be limited e.g. when laying cables or maintaining pipe-work in a trench. Many storage cupboards are small or have limited headroom, requiring handling when stooping, crouching, or leaning. Double handling may be required due to limited space forcing items to be stored in front of or on top of each other.

Handling into a restricted space

Many examples were given of tasks that involved the individual having to lift/lower/push an item into a restricted space (although the amount of space for the handler to stand in may not be limited). For example: undertakers lowering a coffin into the ground; pushing white goods into specified areas in kitchens; and fitting a boiler into a cupboard.

Bulky load or awkward shaped items

Where the actual shape/size/bulk or other characteristics of the item increases the risk of injury. Examples include large items with no handholds (large sheets of metal), fragile items (e.g. glass sculptures, paintings, or musical instruments) or hot/cold items (trays of food or carcasses of meat). Handling loads where the contents may shift was also mentioned e.g. powder in bags, food in containers.

In many instances there were a combination of factors that made handling difficult, such as inadequate handholds and contents that might move (e.g. sack handling).

Further problems arose where the size of the load meant that the arms had to be raised or held away from the body to allow leg movement or to clear the ground (particularly if steps were negotiated). An example of this is when carrying several bags of shopping the arms may have to be abducted to hold the bags away from the legs.

Poor ergonomics

Where the design of the item poses a problem for the individual i.e. inappropriate handle position (e.g. some vacuum cleaners have the centre of gravity low down; the handler has to lift with one hand, holding the item to the side of the body).

Handling while undertaking other tasks

Tasks that involve the person trying to do undertake additional activities while handling e.g. open door while handling; hold lid off bin while placing a bag of rubbish into it.

Alternatively, where the person is required to hold more than one item.

One-off lifting

There may be occasions where the individual is faced with a lifting task that they have never attempted before and where no specific training has been given. Because the number of potential handling situations is infinite it is obviously not appropriate or beneficial to try to specify specific handling techniques to meet every eventuality. Training handlers in the principles that they can apply in different situations will allow them to devise their own technique and should result in better handling.

Repetitive lifting

Situations where the person has to lift items regularly throughout the working day e.g. bricklayer lifting bricks to build a wall. The risk of injury associated with this handling may be compounded if they have to stretch over an existing wall to place the brick (e.g. when building a double layer wall).

Awkward tasks

Shovelling, where the centre of gravity of the load is some distance from the body.

Limitations due to organisation

In many cases, with more space, better planning, or better communication, many of the awkward handling situations detailed could be avoided. The aim of this research was rather to identify the handling situations for which it was not possible to alter the task, load or environment to facilitate handling.

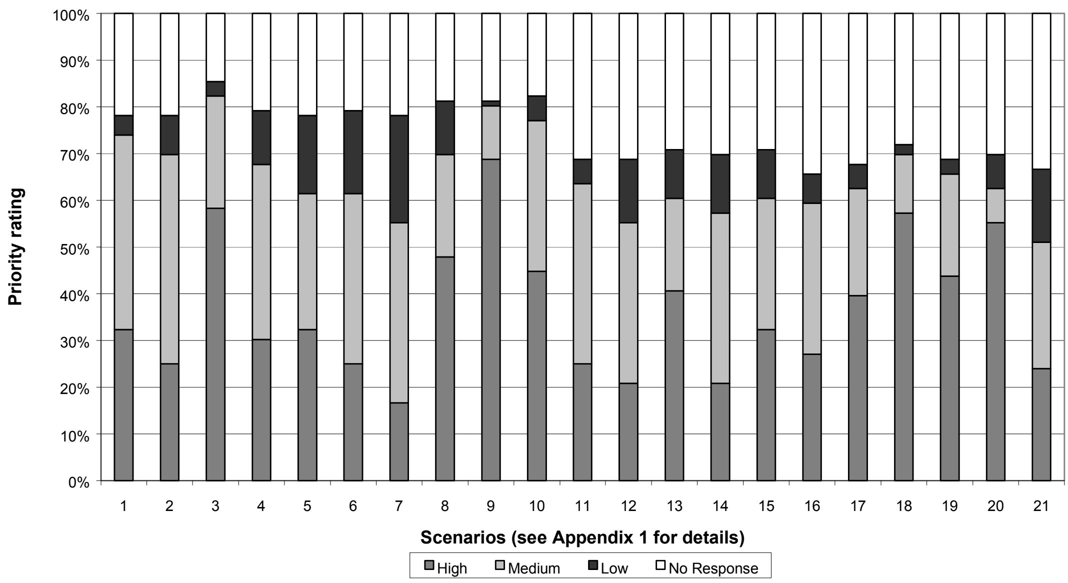
There was some debate about the effectiveness of handling training, an issue referred to by Graveling et al (op cit) and by a number of authors since. However, the issues raised by Graveling and co-workers, namely that workplace designs have to facilitate good handling and the techniques taught have to be correct would still appear to be valid. It is difficult therefore to pass any definitive judgement on this issue.

4.4 QUESTIONNAIRE

At two of the meetings (the Association of Chartered Physiotherapists' conference and the Manual Handler's Co-ordinators Forum), delegates completed a questionnaire, asking them to prioritise the importance of guidance to be provided for selected lifting scenarios identified at the previous workshops (see Appendix 1). A summary of the priority given by delegates to the need for further guidance in these areas is shown in Figure 4.1. It should be noted that delegates responding to this questionnaire were largely involved with patient handling (as well as some non-live load handling).

Attendees were also asked to suggest other examples where the principles laid down in L23 could not be applied. Altogether more than 100 different scenarios were suggested; these have been grouped and summarised under eight main headings in Appendix 2.

Figure 4.1 Chart showing the priority given to the different scenarios (n=96)



It is apparent from reading the list of difficult handling situations that many of them are avoidable. For example, handles are available to insert in manhole covers to enable them to be lifted from a better height or, in a similar manner, kerb lifters (lifting tongs) can enable low-lying loads to be lifted without bending. These serve to highlight the need to promote and publicise good handling solutions that do not necessarily rely on manual handling training. Concerns about the lack of commitment from managers and other authorities also suggest a need for education, possibly reinforced by greater enforcement.

Many however, do present issues that either cannot be resolved by risk reduction measures or where adequate risk reduction could be achieved by the application of appropriate manual handling techniques. In principle, it is recognised that reliance on the application of good handling techniques is not as satisfactory as improvements to task design. Nevertheless, even where modification of the work is technically feasible it may be difficult to justify if the theoretical adherence to correct techniques significantly reduces the risk of injury.

5. LITERATURE REVIEW AND TRAINING MATERIAL

5.1 INTRODUCTION

A literature review was conducted to obtain information on the principles of manual handling. In addition, a selection of training videos on manual handling was also studied to gain an insight into the information on manual handling that was available to industry.

5.2 METHOD

Searches were conducted of a wide variety of CD-ROM based and on-line computer databases which may hold relevant literature citations. A list of search terms was compiled including such terms as 'manual handling'; 'lifting'; and 'awkward postures'. This list was then used to search the databases for reference material. The databases searched included: CISDOC; HSELINE; NIOSHTIC and MEDLINE (Occupational and Environmental subset). The references gathered were then scanned manually. This entailed scanning the title and abstract initially then obtaining the full text if this initial scan suggested possible relevance. The review was then produced, drawing on the references scanned with recourse to the full text for more details where appropriate.

An internet search was performed to gain contact details of companies and individuals who had produced manual handling training videos within the UK. In all, 25 videos were analysed. A list of the training videos viewed can be found in Appendix 3.

5.3 SUMMARY OF LITERATURE

Notes on the literature were compiled into a document that was sent to the Delphi delegates and commentators.

In compiling this, a deliberate decision was made to present the information with no discussion or presentation of opinion that might bias the delegates. Consequently the information obtained was used to generate a series of notes rather than a formal prose style. The notes circulated are given in the ‘Delphi pack’ (Appendix 5).

5.4 SUMMARY OF RECOMMENDATIONS FOR HANDLING FROM CURRENT MANUAL HANDLING VIDEOS AND SOME TRAINING MATERIAL

Over 25 manual handling training videos were viewed to identify the handling principles that are currently being provided. The list below summarises a composite of the principles that were contained in the videos. Additional information from some training material has also been included. Some of these principles conflict with each other, and a different emphasis is placed on the different principles in the different material.

Postures and movements

Back

- Maintain the three curves of the spine at all times (Keep your spine in its natural shape; feel the hollow your back curving inwards).
- Keep your back as straight (flat) as possible.
- Bend your knees, not your back (squat down); lift with your legs, not with your back.
- Use leg and arm muscles rather than back muscles.
- Don’t lock your knees, keep them loose.

- Avoid bending.
- Avoid leaning sideways.
- Avoid stretching.
- Avoid over-reaching.
- Avoid twisting - use the feet to move the body.
- Avoid awkward and uncomfortable postures.
- Don't lift and twist at the same time - lift before turning to face the direction you are going to go.
- Twisting and bending combined can be particularly stressful for the back.
- Don't reach over other items to lift loads.
- Don't reach down and behind.
- Don't handle when seated.
- Be particularly careful to avoid over-reaching when sitting.
- Maintain your balance.
- Don't be top heavy.
- Keep your head up (when lifting from the floor, bring your head up).
- Avoid lifting above head height.
- Avoid lifting at arm's length.
- Safe lifting zone is between shoulder and knee height.
- Keep the load (and your arms) as close to your body as possible.
- Use any available support to take the weight of your body – e.g. when lifting a load from behind a bar or under a table – body is leaning forwards with the upper body weight supported by one hand while reaching with the other to pick up the load. This avoids reaching over when crouching.
- Support your upper body by putting the weight on one hand and reaching forward with the other.
- It may be beneficial in a one handed lift to brace the non-lifting hand against the knee, if lifting between the legs.
- If having to reach and place something inside a box or cage, lean your thighs against the outside of it e.g. lowering battery into engine of car.
- Where you can't bend the knees (e.g. lifting out of the boot of the car) brace them against the back of the vehicle. Bend at the hips, keeping the head and back in a straight line. Lift gradually, using the leg, buttock and stomach muscles.
- 'The more you bend your knees, the less you will use your back.'
- Don't fully bend your knees.
- Raise the head with your chin in just before lifting.
- Directly face the spot on which the load will rest.

Foot position

- Stand as close to the load as you can.
- Place feet apart to create a stable base.
- Place one foot alongside the load and bend the knees so the body remains in a more upright position.
- Position one foot in front of the body for balance (position your feet for good balance).
- Point your leading foot in the direction you will be moving in.
- Make sure your feet are firmly in position.
- Generally, front foot should be beside the object, pointing in direction of travel with back foot slightly behind it; back foot should be hip width from the front foot, to give a stable base and even distribution of weight.

Hands

- Use two hands when lifting.
- Grasp with the palms not just the finger tips.
- Take a firm / good grip - it is up to you to decide which grip is most comfortable, e.g. one hand under, one hand around.
- Ideally, with the proper hold the hands should be diagonally opposite each other for security and comfort. Use the full length of the fingers and where possible, the palms of hand to avoid fatigue.
- Take a hold as low down the load as practical.
- During the lift keep the arms as straight as possible, and keep the elbows in to the side.
- Don’t change your grip while carrying.

Movements

- Make sure your movements are smooth and flowing.
- Don’t jerk the load.
- Don’t rush; lift the load slowly.
- Keep muscles relaxed.

Pushing / pulling

- Push/pull rather than lift.
- Reduce the pushing and pulling required.
- Push rather than pull.
- Correct way to push – supinate your hands when grasping the bar, have elbows in and stand upright. When pushing/pulling, bend your knees to take the strain out of your back.
- Can push with your back against a truck, using your legs.
- If pushing a barrow / cart, have your arms extended and by your side.

Load

- Make the load lighter; don’t carry too much (split the load).
- Carry several small loads rather than one large one.
- Carry smaller loads in each hand rather than a larger load in one hand.
- Make the load secure (e.g. lock doors on filing cabinet, secure load on trolley, remove cables, place lid on saucepans etc).
- Take care with heavier, bulkier items, unbalanced items.
- Place the load in a container if required.
- Push or pull the load into position before lifting.
- Split the load wherever possible.
- Loads that have contents that are liable to shift should be packed as closely as possible before attempting to lift to prevent the contents shifting unexpectedly.
- Don’t overload trolleys.

Preparation

- Stop and think – prepare your mind for the job.
- Examine the load (find out the weight and how it is distributed – e.g. by rocking it – test the load); are there any parts that may be unstable?; how will you grip it; detach cables; use appropriate packaging (e.g. bags); and read labels.
- Check the load is within your capacity.
- Remember the quickest method is not always the safest.

Task / avoid handling

- Don't carry the load further than needed.
- Don't lift anything unnecessarily (roll, rock, pivot or slide items).
- Minimise the handling operations by using mechanical aids.

Workplace layout / route

- Consider the route (e.g. floor surface may be rough or smooth, there may be stairs, ladders, doors) - ensure you have a clear, safe path, e.g. no spillages.
- Consider the placement / destination of the load.
- Have sufficient space so you do not have to side step.
- Move obstacles out of the way before starting to lift.
- Avoid lifting from the floor if possible.
- Avoiding storing items on the floor or below knee height.
- Minimise the distance you have to move objects (horizontally and vertically) by arranging the workplace and loads.
- Frequently moved and heavy items should be stored between knee and chest height.

Clothing

- Wear suitable footwear (or safety shoes).
- Wear clothing that does not hinder movement nor is too loose and may catch on something.
- Wear gloves if the load has sharp edges, staples or splinters or is hot / cold.

Individual capacity

- Don't try to be a hero.
- Only lift what you feel comfortable with; never move a load that is too large for you.
- Ask for help.
- Take rest breaks – don't hold one position for too long.
- Take adequate breaks, particularly if you have to adopt awkward and uncomfortable postures.
- Take it easy.
- Extra caution is necessary if something is difficult to reach.
- Look after your back when not working – do not slouch, exercise regularly.

Team handling

- Lifting capacity is $1+1 = 1^1/_3$; $1+1+1 = 1^1/_2$; $1+1+1+1 = 1^3/_4$.
- Have one person in charge.
- Decide who is doing what before you start.
- Use clear instructions.
- It is best if handlers are similar heights / physiques.
- Share the load evenly.

Other

- Keep hands and feet safe so they will not be crushed when handling (e.g. on trolleys).
- Use the handles on loads or trolleys.
- If the load is very hot get help or use a mechanical aid.
- Applying excessive force when pulling levers is a risk.

5.5 OTHER CONSENSUS FORMING EXERCISES

During the research, two other groups were identified who had recently attempted to establish principles that could be applied for manual handling. One was part of a Back in Work project, (handling of non-live loads); the second was part of a health trust (principles concerned with handling both live and non-live loads).

5.5.1 Back in work project

A number of organisations were attempting to provide principles that could be applied in all handling situations. A Back in Work project (Budworth et al, 2001) identified three basic principles that they felt able to recommend. These were:

1. Position your feet to provide a stable base
2. Keep the load close to your body, within the area of your base
3. Do not twist whilst handling the load.

5.5.2 Derbyshire inter-agency group

The Derbyshire Inter-Agency Group (Fray *et al, 2001)* have produced two Codes of Practice for handling of patients (one for adults, one for children). The Codes of Practice outline eight principles that had been developed by an interdisciplinary team, encompassing ergonomics and biomechanics principles and the neuromuscular approach. Handling procedures outlined in their guidance are based on the agreed principles. The principles are:

Offset base	Carers should adopt an offset base during all handling activities. The use of an offset base gives a wider base of support and stability in all directions. Balance can be improved by relaxing knees and hips when using an offset base.
Close proximity to the load	It is essential to reduce the effect of leverage. This is best achieved by staying as close to the load, or person, as possible.
Mobile base	Carers should be encouraged to follow the movement of the load to maintain short levers and maintain good control of the activity.
Avoid top heavy postures	The body should be in balance throughout all physical movement. Any activity that takes the centre of gravity outside the base of support causes increased muscle work. The body has to use its postural muscles to prevent the body falling over, which then makes physical lifting or moving harder. Top heavy positions can be exacerbated by poor positioning of the limbs or by having a small fixed base.
Avoid twisting	Twisting the spine simply acts to reduce the effectiveness of the joints and muscles. This decreases the body's capacity to do work and increases the chance of injury.
Avoid sustained loading	Muscles are not designed to work for long periods of time. Sustained holding restricts the blood flow in the muscles, increases fatigue and the chance of injury. Muscles should only be active for short periods and then rested. Long term loading should be avoided for poor posture activities and where force is being applied as part of the task. Top heavy postures are indicated as a major cause of sustained holding, as the muscles have to constantly hold parts of the upper body in place.
Avoidance of fixed holds	For applying large forces to certain items, a clenched fist grip is essential. For most care handling activities the aim is to move the person with minimal effort. It is therefore not necessary to adopt a strong fixed fist grip for most of the activities outlined in the care handling guide. An open hand placed on the person needing assistance spreads the load

	across the palm and is more comfortable, for carer and person, and is usually the most appropriate for applying force.
Lead with the head	All moves need to be planned and prepared. The movement of the body should be led from the head. This acts to increase the body’s extension pattern and recruit the large extensor muscles. A posture which maintains flexion in head, neck and trunk will tend to make the person lift with the arms.

6. DELPHI CONSULTATION EXERCISE

6.1 INTRODUCTION

A significant phase of the research was to consult with recognised experts in the area concerning the principles that could be applied for manual handling where those in L23 were not appropriate. Altogether 34 UK experts were identified and invited to the consultation meeting. Of these, 22 agreed to attend, and 12 to comment in writing (due to other commitments on the date). In addition, five international experts were also invited to the meeting; one attended, while two commented in writing. Five of those invited declined to participate due to other work commitments. Twenty delegates attended the Delphi meeting (two had to withdraw on the day), as well as four HSE and three IOM ergonomists.

6.2 METHOD

Letters of invitation were sent to those identified, outlining the research and inviting them to participate. Invited experts were asked to indicate whether they would be able to attend the meeting. Those who were not able to attend were invited to comment in writing on the discussion documents. Delegates travel expenses were paid.

The list of those participating in the discussions is shown in Appendix 4.

In addition, written comments were received from a number of individuals who were unable to attend.

The all day meeting was held on 25th September 2001, at HSE offices in London. Each participant was sent a Delphi pack (Appendix 5) prior to the meeting. The day was divided into three sessions;

Session 1 Principles concerning symmetrical lifting
Session 2 Principles concerning other forms of lifting
Session 3 Principles concerning carrying

In the event, the Session 1 discussion proved so extensive and prolonged that little time was available for later sessions. The comments made on the day and those provided in writing beforehand proved very informative and illuminating. To avoid unnecessary duplication, key points raised during the discussion are included in Section 6.4 with those from the post-Delphi questionnaire respondents. The authors would like to reiterate their thanks to those involved (see Acknowledgements and Appendix 4).

6.3 OUTCOME OF DELPHI EXERCISE

Session 1

Twelve principles were proposed to replace those currently found in L23. These are outlined below. Votes were obtained for most of these during the meeting. Absolute numbers are not presented as the number present varied due to the late arrival of some delegates. Instead, a rating system is presented consisting of three categories: 'strong support' (+++) - 80% or more; 'moderate support' (++) - 60-80%; and 'weak support' (+) - 55-60%. None of the principles presented below received less than 55% support (except for the one where no vote was held). Delegates had two votes to enable them to indicate the strength of their support. Where more than one delegate expressed opposition this is also indicated (-). However, it should be noted that delegates often commented that they were voting against the wording suggested, not the principle itself.

1 **Try to warm-up prior to handling (+:-)**
Warm-up the muscles before lifting by performing simple stretching exercises.

2 **Plan the task (+++)**
The how, when and where of lifting.

3 **Prepare for the handling task (+++)**
Stabilise the load; split the load if appropriate.

4 **Minimise the horizontal distance between lower back of the handler and the centre of gravity of the load throughout the manual handling operation (+++)**
Where possible, hold the item close to the body.

5 **Create and maintain a stable base (+++)**

- Have the feet apart with one leg forward.
- Be prepared to move your feet if necessary.

6 **Get a secure hold of the load (+++)**
Use handles if available, balance the load.

7 **The lumbar spine, hips and knees should be moderately flexed (bent) at the start of the lift (++)**

8 **Don't flex the spine any further as you lift (++)**

9 **Try not to twist the trunk or lean sideways especially while the back is bent (+++)**

10 **Keep your head up when handling (no vote)**

11 **Move smoothly (++:-)**
Try not to jerk when lifting as this could result in injury (e.g. parts of the item may slip as you attempt the lift).

12 **Don't move more than you can easily manage (+:-)**
If in doubt, don't lift the item. Seek help or use a lifting aid to move the item to its desired position.

Session 2 and 3

Session 2 (principles regarding lifting in awkward situations where the standard symmetric lift could not be applied) and session 3 (carrying while lifting) were not discussed in detail during the Delphi exercise due to the extensive discussions of the principles concerning symmetrical lifting.

6.4 OUTCOME OF QUESTIONNAIRE

Although extensive debate and thought went into establishing these 12 principles, it was felt right to allow delegates time to reflect on these and the wording eventually selected. A questionnaire presenting the principles was therefore circulated to delegates following the meeting and they were invited to indicate their level of agreement with these. Delegates were asked if they agreed or disagreed on each principle and space was given for them to write any comments they thought were pertinent to the specific principle. Delegates where also asked to prioritise the principles that had been suggested at the workshop meetings. Only nine individuals completed the questionnaire and returned it to the IOM. Table 6.1 indicates the responses received, determined by summing the rankings given by the individual respondents.

The results would seem to place the greatest importance on minimising the horizontal distance between the lower back of the handler and the centre of gravity of the load throughout the manual handling operation. Planning the task itself was voted as being the second most important principle followed by attaining a secure hold on the load.

Table 6.1 Overall priority given to the selected principles (results based on nine respondents)

No	Principle	Priority
1	Try to warm-up prior to handling	12
2	Plan the task	2
3	Prepare for the handling task	7
4	Minimise the horizontal distance	1
5	Create and maintain a stable base	4
6	Get a secure hold on the load	3
7	The lumbar spine, hips & knees moderately flexed	5
8	Don't flex the spine	8=
9	Try not to twist the trunk or lean sideways	6
10	Keep your head up when handling	11
11	Move smoothly	8=
12	Don't lift more than you can manage	10

Warming-up prior to handling was assigned the lowest priority. Indeed a number of experts at the Delphi meeting questioned whether or not there was any evidence to support it as a principle and it was consequently accorded one of the lowest votes. Nobody present was aware of any such evidence although several considered it to be virtually self-evident. This was the only issue in which there was any dispute over the basic concept. In order to resolve this, a specific literature survey was conducted and an overview produced. This is presented as Appendix 6. In essence, the outcome of this was that there was no scientific evidence to support the inclusion of advice to warm-up prior to handling in any guidance given.

The next principle to be accorded a low priority was that of ‘keeping the head up’. Here the conflict was more over what was intended by that statement rather than the principle itself. Some advocated it as a precursor to lifting as it was believed to promote the adoption of a lower (lumbar) lordosis prior to lifting. Others were in favour of ‘leading with the head’ a dynamic approach in which the lifting action originated by lifting the head and then the shoulders in a fluid movement. There was no formal vote on this during the meeting, due to the difficulties in agreeing a phrase that met with sufficient approval. This issue is discussed further in Section 9.2.8.

In many other instances there was some debate over the clearest or most appropriate wording to use to convey the basis behind the principle. Concerns were expressed that concentrating on short, terse statements resulted in a degree of ambiguity. Conversely, expressing the principle in a scientifically exact manner gave rise to statements not readily understood by crucial audiences. An examination of this issue by trainers is given in Section 7.

Respondents were also ask to state whether they agreed or disagreed with each principle being applied to awkward lifting scenarios such as one handed lifting and lifting in a confined space. The results can be seen in Tables 6.2 to 6.9. They were also asked to suggest other principles that could be employed under each scenario.

Key to Tables: ++ = Strongly Agree; + = Agree; **0** = No Opinion; - = Disagree; - - = Strongly Disagree; **NR** = No Response

Table 6.2 One handed lifting

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	3	2	0	0	3
2	Plan the task	4	3	1	0	0	0
3	Prepare for the handling task	2	2	0	1	0	3
4	Minimise the horizontal distance	5	0	2	0	0	0
5	Create and maintain a stable base	3	4	1	0	0	0
6	Get a secure hold	4	4	0	0	0	0
7	The lumbar spine, hips and knees moderately flexed	3	4	1	0	0	0
a	Spine moderately flexed	0	5	1	0	1	1
b	Hips moderately flexed	1	5	1	0	0	1
c	Knees moderately flexed	1	5	1	0	0	1
8	Don't flex the spine any further	1	4	0	0	0	3
9	Try not to twist or lean sideways	1	4	0	3	0	0
10	Keep the head up when handling	0	4	2	1	0	1
11	Move smoothly	2	6	0	0	0	0
12	Don't lift more than you can easily manage	1	7	0	0	0	0

In general, most respondents agreed or strongly agreed with all the principles if faced with a one handed lift. There was some concern with principle 9 "try not to twist the trunk or lean sideways especially when the back is bent" though no reasons were given as to why respondents disagreed with this principle.

One respondent suggested that a person should not lift if their muscles were fatigued and that they should stop lifting before the muscles became fatigued as a principle that could be employed for each of the scenarios.

Table 6.3 Large bulky loads

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	1	3	1	3	0	3
2	Plan the task	6	2	0	0	0	0
3	Prepare for the handling task	2	2	0	3	0	3
4	Minimise the horizontal distance	5	2	0	1	0	1
5	Create and maintain a stable base	4	4	0	0	0	0
6	Get a secure hold	6	2	0	0	0	0
7	The lumbar spine, hips and knees moderately flexed	3	4	0	1	0	1
a	Spine moderately flexed	1	4	0	1	1	1
b	Hips moderately flexed	1	6	0	1	0	1
c	Knees moderately flexed	1	6	0	1	0	1
8	Don't flex the spine any further	1	4	0	3	0	3
9	Try not to twist or lean sideways	2	6	0	0	0	0
10	Keep the head up when handling	0	5	1	1	0	1
11	Move smoothly	2	6	0	0	0	0
12	Don't lift more than you can easily manage	2	6	0	0	0	0

There was some disagreement with a number of principles suggested when lifting large bulky loads. Three individuals disagreed with warming-up as compared to four whom either agreed or strongly agreed with this principle. No reasons were given as to why this should be the case. Many of the respondents believed that principle 3 and 4 should be combined and "plan the handling task" received a more positive response (8 positive responses compared to only 4 for "prepare for the handling task").

There were no alternative principles suggested for lifting large bulky loads.

Table 6.4 Large flat, vertical loads

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	4	1	0	0	3
2	Plan the task	6	2	0	0	0	0
3	Prepare for the handling task	2	2	0	1	0	3
4	Minimise the horizontal distance	5	2	0	0	0	1
5	Create and maintain a stable base	3	5	0	0	0	0
6	Get a secure hold	5	3	0	0	0	0
7	The lumbar spine, hips and knees moderately flexed	3	4	0	0	0	1
a	Spine moderately flexed	0	5	0	1	1	1
b	Hips moderately flexed	1	6	0	0	0	1
c	Knees moderately flexed	1	6	0	0	0	1
8	Don't flex the spine any further	0	5	0	0	0	3
9	Try not to twist or lean sideways	2	3	0	3	0	0
10	Keep the head up when handling	0	5	1	1	0	1
11	Move smoothly	2	6	0	0	0	0
12	Don't lift more than you can easily manage	1	7	0	0	0	0

Most of the respondents agreed with the 12 principles that had been suggested with only "try not to twist or lean sideways" receiving more than one negative response (3, compared to 5 who agreed or strongly agreed with this principle).

No alternative principles were suggested for lifting large flat, vertical loads.

Table 6.5 Lifting from a container

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	3	2	0	0	3
2	Plan the task	4	4	0	0	0	0
3	Prepare for the handling task	2	2	0	1	0	3
4	Minimise the horizontal distance	4	3	0	0	0	1
5	Create and maintain a stable base	1	5	1	0	1	0
6	Get a secure hold	2	5	0	0	0	1
7	The lumbar spine, hips and knees moderately flexed	2	3	0	0	1	2
a	Spine moderately flexed	1	4	0	0	1	2
b	Hips moderately flexed	1	4	0	0	0	3
c	Knees moderately flexed	1	4	0	0	0	3
8	Don't flex the spine any further	0	5	0	0	0	3
9	Try not to twist or lean sideways	2	3	1	1	0	1
10	Keep the head up when handling	0	3	2	1	0	2
11	Move smoothly	2	6	0	0	0	0
12	Don't lift more than you can easily manage	2	5	0	0	0	1

In general, the respondents agreed with all the principles suggested and six suggested bracing as a principle when lifting from a container i.e. use hands to brace yourself; brace knees against side of container and use a secondary support (brace). Bracing was seen to allow reduction of the horizontal distance between the load and the base of the spine.

Table 6.6 Lifting when there is limited headroom

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	3	2	0	0	3
2	Plan the task	5	2	0	0	0	1
3	Prepare for the handling task	2	1	0	1	0	4
4	Minimise the horizontal distance	6	2	0	0	0	0
5	Create and maintain a stable base	3	5	0	0	0	0
6	Get a secure hold	3	3	0	0	0	2
7	The lumbar spine, hips and knees moderately flexed	2	3	0	1	0	3
a	Spine moderately flexed	2	3	0	0	1	2
b	Hips moderately flexed	1	4	1	0	0	2
c	Knees moderately flexed	1	4	1	0	0	2
8	Don't flex the spine any further	1	4	0	0	0	3
9	Try not to twist or lean sideways	2	6	0	0	0	0
10	Keep the head up when handling	0	3	2	2	0	1
11	Move smoothly	2	6	0	0	0	0
12	Don't lift more than you can easily manage	2	5	0	0	0	1

Again most respondents either agreed or strongly agreed with the principles suggested with only one strong disagreement on moderately flexing the spine. Again bracing was suggested as an additional principle as was kneeling and push/pull the load rather than lift. Another suggestion was to minimise the time spent in a stooped posture by task rotation, task expansion or kneeling.

Table 6.7 Lifting while seated

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	2	3	0	0	3
2	Plan the task	3	5	0	0	0	0
3	Prepare for the handling task	1	2	0	1	0	4
4	Minimise the horizontal distance	5	3	0	0	0	0
5	Create and maintain a stable base	0	3	3	0	0	2
6	Get a secure hold	4	3	0	0	0	1
7	The lumbar spine, hips and knees moderately flexed	1	1	0	0	0	5
a	Spine moderately flexed	0	3	0	0	1	4
b	Hips moderately flexed	0	1	1	0	0	6
c	Knees moderately flexed	0	1	1	0	0	6
8	Don't flex the spine any further	0	4	1	0	0	3
9	Try not to twist or lean sideways	2	6	0	0	0	0
10	Keep the head up when handling	0	2	2	2	0	2
11	Move smoothly	1	7	0	0	0	0
12	Don't lift more than you can easily manage	1	6	0	0	0	1

There were only three individuals who disagreed with two of the principles suggested (two for keeping the head up when handling and one who strongly disagreed with keeping the spine moderately flexed while lifting).

Table 6.8 Lifting light loads that are low down

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	3	2	0	0	3
2	Plan the task	3	3	1	0	0	1
3	Prepare for the handling task	1	1	1	1	0	4
4	Minimise the horizontal distance	5	2	1	0	0	0
5	Create and maintain a stable base	0	6	2	0	0	0
6	Get a secure hold	1	6	0	0	0	1
7	The lumbar spine, hips and knees moderately flexed	2	3	2	0	0	1
a	Spine moderately flexed	0	4	1	0	1	2
b	Hips moderately flexed	0	4	2	0	0	2
c	Knees moderately flexed	0	4	2	0	0	2
8	Don't flex the spine any further	0	4	0	0	0	3
9	Try not to twist or lean sideways	2	5	0	0	0	1
10	Keep the head up when handling	0	3	1	2	0	2
11	Move smoothly	1	7	0	0	0	0
12	Don't lift more than you can easily manage	1	5	0	0	0	2

One respondent suggested pushing or pulling the load rather than attempting to reach the load (which may unbalance the person).

Table 6.9 Team lifting

No	Principle	++	+	0	-	- -	NR
1	Try and warm-up prior to handling	0	4	2	0	0	2
2	Plan the task	5	2	0	0	0	1
3	Prepare for the handling task	3	0	0	1	0	4
4	Minimise the horizontal distance	3	3	1	0	0	1
5	Create and maintain a stable base	3	5	0	0	0	0
6	Get a secure hold	6	2	0	0	0	0
7	The lumbar spine, hips and knees moderately flexed	3	3	0	0	0	2
a	Spine moderately flexed	1	4	0	0	1	2
b	Hips moderately flexed	1	5	0	0	0	2
c	Knees moderately flexed	1	5	0	0	0	2
8	Don't flex the spine any further	1	4	0	1	0	3
9	Try not to twist or lean sideways	2	5	0	0	0	1
10	Keep the head up when handling	1	2	1	2	0	2
11	Move smoothly	2	6	0	0	0	0
12	Don't lift more than you can easily manage	2	5	0	0	0	1

Three respondents mentioned the need for co-operation and suggested that there should be some form of principle that highlighted this suggested. Examples given included: ensure good understanding of lifting commands; appoint a team leader to co-ordinate the lift then move on a given signal such as "ready, set, lift"; or co-ordinate with your partner.

7. RE-EXAMINATION OF PRINCIPLES

7.1 ACCEPTABILITY OF PRINCIPLES BY PRACTITIONERS

Two further workshops were held with manual handling practitioners to determine whether the principles suggested by the Delphi experts could be utilised in the working environment. These were with members of IOSH and at a further meeting of the Manual Handling Co-ordinators Forum. Attendees were shown the suggested principles and were asked to comment on each principle during the meeting. A further meeting was then held on the 25th February 2002 to discuss the principles that had been suggested at the previous workshops and to refine the wording employed for each proposed principle. Six individuals attended this final meeting. In addition to IOM project team members these were all practising manual handling trainers. They were invited as being from a variety of backgrounds and training philosophies to help ensure the inclusiveness of the outcome.

1) Warming-up

There was much debate on whether warming-up would prove beneficial prior to lifting given that there are various definitions of warming-up and that each person's perception of exercise would be different.

It was thought that fitness levels in general have reduced in recent years and a study carried out by one of the delegates seemed to confirm this. The study (over 3 years) had shown that 70 % of participants asked to swim 60 metres could not pull themselves out of the water on completion of the exercise. The correlation between fitness and susceptibility to injury was raised in that injuries often occurred at the beginning of a shift or when there was poor circulation of blood to the extremities. However, fitness was recognised as a different issue to warming-up.

The lack of time available for training was highlighted but it was felt that there should be some form of principle involving "warming-up". This should include what a person shouldn't do along with what they should. Warming-down at the end of the lifting exercise was also suggested.

These meetings were conducted before the review of the literature revealed that there was no clear scientific evidence to support any beneficial role for warming-up in preventing injury.

2 and 3) Planning the task and prepare for the handling task.

There was some confusion over these statements in that some believed they represented the same thing. Clarification was provided but it was thought that these statements could be combined in some way in order to allow the person to perform a micro-assessment prior to lifting.

4) Minimise the horizontal distance

All believed this statement was harder to understand than the phrase 'keep the load close to the body' traditionally used. There was also concern raised that if a person was not in an upright position, then minimising may result in the person not holding the item close to the body. It was suggested that clarifying the role of the distance from lower lumbar spine may prove useful in that some claimed that most individuals try to lift an item to a higher position then let it settle to the optimum position.

It was noted that this principle was still part of the preparation and that the person had not actually lifted the item yet and as such *"get close to the item before you move"* was suggested as an alternative term.

5) Create and maintain a stable base

The delegates agreed that there was need to emphasis the dynamic approach while maintaining stability. The wording in L23 suggested having the feet apart with one leg forward. Concern was raised as to the actual meaning of this – how far forward should the leg be? It was also noted that stability suggested fixed rather than dynamic and that the person should generally attempt to adjust their balance throughout the lift. All agreed that the principle should be easy to understand as often employees did not have access to additional training packages which could visually show what was meant, therefore the wording became crucial.

Adopting a stable base was suggested as an alternative but this was rejected in that it suggested the feet were together and that a degree of asymmetry was preferred. To overcome this, it was then suggested that the principle should be in bold writing with an explanation underneath. For example;

Adopt a stable stance
Have the feet slightly apart with one leg slightly forward to help maintain balance.
Be prepared to move the feet.

6) Get a secure hold

The main concern with this principle related to the wording. A change from "grip" to "hold" was suggested as grip implied using the fingers and holding the item tightly which may not be beneficial. It was also agreed to change 'get' to 'ensure' then provide an explanation underneath. After further consultation it was agreed to change the wording to;

Ensure a good hold on the load
Followed by details such as hugging the load etc…

7) The lumbar spine, hips and knees should be moderately flexed (bent) at the start of the lift

All agreed that the principle should be easy to understand. There was some discussion on the centre of gravity of a larger load and that foot positioning was important. All thought the back should be relaxed and that the person should avoid deep knee bends as well as a fully-flexed back. It was suggested that the person should get as close as they can to the load with the person relaxing the knees first then the hips and spine.

The delegates suggested that the wording should be;

Soften or relax the knees, hips and back to reach the load. Avoid fully bending the knees and back.

8) Don't flex the spine any further as you lift

One of the delegates thought this statement was meaningless and a fuller explanation was provided in that it came from "if the hands trailed behind the hips or knees then there would be further flexion / back extension".

There was some discussion on the development of a baby where the back provides stability thus allowing the infant to use their arms and legs to move and explore the area close to them. It was noted that the principle was based on spinal loading rather than actual movement and no alternative was proposed.

9) Try not to twist the trunk or lean sideways especially when the back is bent

No comments were made on this principle.

10) Keep the head up

One person suggested combining principle 8 with principle 10 as they were connected to the dynamic aspect of lifting and that it was important to emphasis adjusting the foot position if necessary (thus removing the static element).

There was some concern that "leading with the head" suggested the person moved the head, then the shoulders and finally the back and this was not balanced. One delegate then argued that leading with the head resulted in the weight of the item being distributed throughout the body but it was suggested that leading with the head risked the back muscles being used first when lifting and therefore subject to the initial inertia of the load.

There was then a discussion on the leg muscles being stronger than the back and that they were able to withstand more force. A phrase that included dynamic movement of both the leg and back muscles was proposed.

Wording;

Use both leg and back muscles when lifting

Suggested final wording;

1) Get close to the item before you move

2) Adopt a stable stance
Have the feet slightly apart with one leg slightly forward to help maintain balance. Be prepared to move the feet.

3) Ensure a good hold on the load
Followed by details such as hugging the load etc…

4) Soften or relax the knees, hips and back to reach the load. Avoid fully bending the knees and back.

5) Use both leg and back muscles when lifting

It is apparent from this brief summary of the discussion that there are difficulties in conveying scientifically correct statements in a manner which is both unambiguous and easy to understand. A good example of this is 'get the load close to the body' against 'minimise the horizontal distance between the load and the lumbar spine'. Whilst subsidiary notes can help to clarify the meaning, the 'headline' phrases will need to be selected carefully. It is also difficult to separate the principle from the technique in some instances. Thus, although the important role of head position in influencing the shape of the spine at the start of the lift is recognised, phrases such as 'lead with the head' whilst conveying a particular message to the proponents of particular approaches to lifting can be misinterpreted by others. It is possible that a degree of scientific precision will have to be sacrificed in ensuring ease of understanding.

Ultimately, it was clear that there was a reasonable consensus amongst delegates to the Delphi meeting; respondents to the subsequent questionnaire; and experts and practitioners consulted elsewhere, concerning the underlying principles. It was equally clear however that different individuals (experts and practitioners) had different personal 'slants' on presentation, leading to different preferences for text. Therefore, whilst these discussions were valuable in helping to frame the presentation of the principles, the wording selected by the participants in any part of the consultative process was not always subsequently adhered to. In some such instances, the wording in the current version of L23 was retained as there was no scientific reason for change. In others, the principal author (RAG), having participated in the Delphi meeting and all subsequent meetings, derived forms of words that seemed to fit most closely with the majority held view, hopefully without alienating others of a different persuasion. These words and phrases are presented in Section 9.

8. SCIENTIFIC BASIS FOR ADDITIONAL PRINCIPLES

8.1 INTRODUCTION

Prior to the Delphi exercise, a scan was carried out of the published scientific literature to identify experimental evidence that might be of value to the experts in formulating their opinions. The experts were derived from differing areas of relevant expertise and it was anticipated that some, particularly those more involved in practice rather than research, might be less familiar than others with the background material. This evidence was prepared in the form of annotated notes, rather than a formal review, in order to avoid unduly influencing the opinions of those assembled (see Document 4, Appendix 5).

Following the Delphi exercise, it was apparent that, although the exercise had been reasonably successful in relation to the central issue of the two-handed symmetrical lift it had been less satisfactory in defining the requirements for other forms of lifting where conventional teaching was inapplicable.

It is clear that the basic principles, based largely on minimising the load on the spine, are seen by the experts as fundamental to any form of lifting. However, when these principles are not applicable because of the circumstances surrounding the nature of the load or in the environment in which the handling activity is taking place, then no further principles (as opposed to techniques) have been offered by any of the experts. In addition, it was not possible to use the collected views of the experts to assign any relative importance ('pecking order') to the principles as the consensus seemed to be that they were all equally important. Thus, for example, in lifting a large bulky load which cannot be brought between the knees, the collective opinion of the experts offered no guidance as to whether it was better either for the load to be kept close to the body (by stoop lifting) or for the back to be kept relatively straight by lifting from outside the bent knees (effectively at arm's length).

The preliminary workshops made it apparent that there were many lifting situations where such conflicts arose and where guidance was therefore required. Consequently, a further more detailed review of the literature was conducted to try and provide the scientific basis for further guidelines. The intention was to allow instructors and others involved with handling training, to provide guidance on resolving these 'different' lifting scenarios. This section briefly summarises this evidence in relation to the 'other' handling techniques (as examined in Section 6.4)

8.2 ONE-HANDED LIFTING

In one-handed lifting, there is often lateral bending; asymmetric loading of the spine; and possibly torsion as loads are often lifted from the side and brought to the front. Using a risk prediction model, Allread et al (1996) calculated that the changes in back motion characteristics and consequent trunk loading meant that one-handed lifting increased the risk of injury by 7% for the same lifting manoeuvre performed with two hands. Basic studies of the biomechanics of the spine, summarised by White and Panjabi (1990), have shown that a combination of compression and lateral flexion maximises any tendency for the intervertebral discs to bulge. The authors illustrate how these loading, when combined also with forward flexion, create circumstances in which sudden disc prolapse can occur, although the compressive loading has to be considerable (and sudden). Early studies including those by Farfan and co-workers (Farfan et al, 1970; Farfan 1977) illustrated how torsional loading could play a contributing role in disc degeneration. These parameters are clearly therefore of importance in one-handed lifting.

Marras and Davis (1998) reported studies of compressive and shear forces with asymmetric lifting with one or two hands. The study showed that compressive force was least with one-handed lifting using the hand on the same side as the twist (e.g. left-hand when twisting to the left). It is difficult therefore to derive any practical guidance from this work. The disc compression data would suggest using the same side hand whilst the lateral shear data would indicate using the opposite hand (i.e. reaching across to the left and lifting with the right hand). The authors cite the widely used value of 3400N for a 'tolerance level' for compressive loading. For the 13.6kg load lifted (30lb) average compression forces exceeded this for all lifts. In contrast, a value of 900N for lateral shear was at least twice average values. On this basis, the lifting style that minimises compression force (same side, single hand) would appear to be the preferred action. Finally, it should be noted that this study found little difference between forces when using both or either hand singly when performing a symmetrical lift.

The utility of these results is limited because, in order to facilitate comparisons, all lifts were performed with the feet symmetrically placed in the sagittal plane.

Huang et al (1998) reported studies of pull forces created in lateral flexion. The results showed that the greatest pull force was achieved when leaning slightly towards the load. This tends to reinforce the observed 'natural' tendency of individuals to lift in this manner. However, although the effect appeared to be consistent it was not substantial, being comparable to the level of variation between trials.

A commonly observed lifting situation in which one hand is often used is that of lifting from a bin or other container (such as a frozen food cabinet). Ferguson et al (2002) reported the results of a comparative study of using one or two hands to lift from inside a simulated bin. A further degree of industrial realism was introduced by including a lift where the subject was encouraged to stand on one leg. This is often observed in reaching towards the rear of a container, the outstretched leg apparently serving as a counterbalance. Recordings of EMG were used as the basis for an 'EMG-assisted' predictive model of spinal forces. In a second phase of the study, another often observed technique was examined by allowing the subjects to use their free hand to support or brace themselves against the front of the container. Previous early work by Ridd (1985) had suggested that being able to brace the body against a knee or waist 'barrier' increased safe lifting capacity.

The study by Ferguson and co-workers showed differences between lifting styles and differing patterns depending upon the parameter being assessed. Thus, lateral shear forces were always lowest in using two hands and two feet on the ground even when stretching to reach the far back of the container. The one-handed lifting technique created more than 100% more lateral shear force than two-handed but there was no significant difference for antero-posterior shear or compression. Standing on one leg created 32% more shear force and 8% more compressive load. Supported lifting reduced all three spinal loading parameters by around 15-17%. As might be expected this effect was greater for lifting from the lower levels. Not all results are presented in full and it is difficult therefore to compare the advantage of bracing with the disadvantage of only using one hand (leaving the other free for bracing). A further complication is that the 'bin' used, simulated one with a fold down front so that the lower reaches did not entail reaching down into a container. The container front (and therefore the bracing height) was therefore 94cm high for the top level lifts (just below elbow height for a 5th percentile adult) and 64cm for the low level lifts (just below knuckle height for a 5th percentile adult).

From this study, the unequivocal guidance to keep both feet on the ground can be provided. The authors also advocate the use of a one-handed, supported lift when reaching to the rear or base of a container. Presumably in doing so they have concluded that the 100% increase in lateral shear force of one-handed lifting is outweighed by the 15% decrease in shear and compression with support. This would seem to contradict the recommendations of Holmes (1997) in relation to patient lifting. At one time, the technique of the shoulder lift used to be advocated for transferring patients between a bed and a chair or toilet (Corlett et al, 1992).

The technique centred around the use of the free hand to brace during the lifting manoeuvre. However, as Holmes explains, a re-examination of this lift indicated that, the bracing arm had to be removed whilst the lifters were still in a flexed posture. Consequently it was concluded that in this posture the horizontal distance of the load (patient) to the base of the spine was excessive, creating what was assumed to be an unacceptably high compressive force on the spine. Clearly, the forces involved are going to be much greater in lifting a 51kg patient than a 11.3kg box. Ferguson et al indicate that, despite the 100% increase in lateral shear forces in using one hand rather than two, comparisons to vertebral tolerance of shear forces indicate little difference. Lifts in the lower back region of the bin resulted in 16% of one handed lifts and 6% of two-handed lifts exceeding the tolerance value of 1000N quoted. With supported lifts from the same area 18% of unsupported lifts exceeded the tolerance level and 9% of the supported lifts. There appears to be a discrepancy here as the one-handed lifts (16%) should be the same as the unsupported lifts (18%). However, although the differences are not great, it would appear that two handed lifting results in fewer lifts exceeding the tolerance level for lateral shear. On this basis it would seem difficult to support the conclusions of the authors to use one-handed, supported lifts. However, a modified statement that two-handed lifts should be used where possible and, where not possible, a one-handed supported lift should be used would seem to be consistent with the results quoted.

In summary therefore, when lifting to the side of the body, a one-handed lift is preferable. However, when lifting in front of the body a two-handed lift is to be preferred but, if only one hand can be used for some reason then using the second hand to support the body confers some benefit.

8.3 LIFTING LARGE BULKY LOADS

In lifting large, bulky loads, from lower heights, the bulk of the load prevents it from being brought between the knees. Even with a ‘correct’ asymmetric foot posture, the centre of gravity of the load is effectively beyond the knees and therefore at or around arm’s length away from the body. A graphic illustration of this is given in the photographs of starting postures presented by Holmes et al (1992). The alternative is to employ a stooped lift which has the merit of allowing the load to be held close to the body throughout the lift.

Leskinen et al (1983a) reported that, using a static model for calculating spinal compression, back lifting created similar levels of peak compression to leg lifting. However, when a dynamic model was used, leg lifting compression was significantly lower. In a related paper (Leskinen et al, 1983b) the authors explain that, in both cases the load was lifted from a low shelf close to the body.

However, Anderson and Chaffin (1986) cited studies which suggested that, with bulky loads, the stoop lift was preferred as it minimised the moment arm of the load. The authors presented findings that confirmed this, where a parallel squat with a curved back was involved (such as when lifting from the ground where a straight, upright back cannot be maintained). However, what was described as a ‘straddle stance’ with a ‘flat back’ produced the lowest levels of disc compression.

More recent studies have benefited from improvements in predictive models, with more parameters taken into account. They have also recognised that disc compression is only one of a number of measures that can be used to predict injury risk. Unfortunately, critical factors in the interpretation of the results are not always presented. For example, Potvin et al (1991) do not report load dimensions or provide any other indicator of the horizontal location of the hands at the start of the lift. It is therefore difficult to interpret their findings that peak vertebral compression was lower in stoop lifting than squat lifting whilst peak shear forces were greater in stooping. The shear forces were considered to be influenced more by the degree of trunk flexion than the style of lift. Thus a graphical presentation shows how changing from a fully flexed (kyphosis) to a lordotic posture without changing hand position considerably reduces shear force whilst compression remains stable. This appears to advocate a 'straight back' crane style of lift rather than lifting with a pronounced forward flexion.

The illustration of the lifting posture utilised by Dolan et al (1994) clearly shows a start point for the lift beyond the knees. The preamble to this paper emphasises the importance of combined bending and compressive forces in the causation of such injury. The results showed that whilst bending torque was markedly higher with stoop lifting compared to squat lifting, there was little difference in the extensor moment created by the back muscles. As many back injuries give rise to so-called 'mechanical' pain, involving muscles and ligaments rather than the intervertebral discs, this may be of importance. Several other variables studied presented findings relevant to lifting large, bulky loads. Thus the authors studied the effect of bulk, (by placing the same metal weight into a series of boxes of increasing size) and horizontal load distance. Bulk did not have a systematic effect on back flexion during squat lifts (although the largest load was only 60cm wide) but significantly increased peak bending torque and peak extensor movement for the bulkiest load. Similar significant trends were documented for the horizontal load distance.

Unfortunately, only squat lifts were utilised for this part of the study so, although demonstrating the influence of bulk and distance on truncal strain, the study does not allow direct comparisons between different techniques. However, from indirect comparisons it can be estimated that moving the 10kg load away from the body from 30cm to 60cm with a squat lift has a similar impact on peak bending torque as stoop lifting a load of 20kg whilst the effect on peak extensor movement is greater than stoop lifting a 30kg load. These figures illustrate the potential impact of load size implying that, under some circumstances at least, stoop lifting might be preferred to squat lifting.

Finally, the results of a major review of biomechanical studies on lifting technique were reported by Dieën et al (1999). The authors selected 27 studies for inclusion. As might be expected, variations in differing aspects of the experimental techniques and procedures adopted make direct comparisons difficult. Nevertheless, the authors conclude that the cumulative body of evidence indicated that squat lifting was to be preferred over stoop lifting only when a load could be lifted from between the feet. This would clearly not apply with bulky loads. With other lifting tasks, the net movement and compressive force tended to be lower with stoop lifting whilst shear and bending movements were higher. The authors advocate comparing typical values for each parameter against injury risk criteria to provide a comparative weighting for these effects. On this basis, using either technique, the typical bending movements are well below the suggested injury threshold and this parameter can therefore be discounted. Similarly, with reported shear forces possibly as little as one tenth of the damage risk criterion, differences in shear forces between techniques appear negligible. The authors do however consider compressive force to be important in damaging spinal motion segments suggesting that this is an important parameter. Similarly, net movement, which the authors suggest should be related to muscle strength, also takes on an important degree of significance because calculated movements can be a similar order of magnitude to muscle strengths, indicating an injury risk. With net movements and compressive forces tending to be lower with stoop lifting it would appear that emphasising squat lifting over stoop lifting will be of little protective value. In summary therefore, with the constraints imposed on lifting technique in lifting large, bulky loads there would seem to be little benefit in advocating bent knee lifting over stooping. Far more important would seem to be encouraging those lifting such loads to adopt a technique which allows them to keep the load as close to the body as possible, implying that this lifting principle is of paramount importance.

8.4 LARGE, FLAT VERTICAL LOADS

Lifting large, flat vertical loads imposes similar constraints to bulky loads i.e., if the load is lifted symmetrically then bending your knees to lift them means that the load is outside your knees. The same issues would therefore apply as in Section 8.3 above with the same principle of keeping the load close to the body taking precedence over bending your knees not your back. An alternative to this, and one that might be more practicable if the load has to be carried any distance, is lifting the load to the side of the body. In these circumstances, it is possible to bend the knees to lift, keeping the load against the side of the body,

However, this necessitates a degree of trunk twisting to grasp the load. Once again, the question arises, which of these approaches places the body under least strain. In this context the emphasis will be on the load on the trunk although it must be recognised that, with large loads arm or shoulder strain may also be an issue.

White and Panjabi (op cit) cited basic clinical biomechanical evidence to show that rotation, lateral flexion and compression rendered the spine particularly susceptible to injury. In addition, a number of authors have recognised the potential importance of muscle loading and consequent strain.

Marras and Mirka (1990) demonstrated increased recruitment of different muscles with asymmetric trunk angles, with particular emphasis on ‘small, thin oblique muscles’ such as the internal and external obliques. They suggested that the relatively small size of these muscles meant that they could be easily stressed. Studies suggested that muscle loadings were particularly high when loads were lifted with a twisting action. Less strain was created when the action was one of lifting then twisting. However, work of Plamondon et al (1995) qualified this, indicating that, if the trunk was twisted at the start of a lift it was preferable to straighten and then lift if possible rather than lifting first as, in the latter case the lift extension was being performed with the trunk in a state of torsion. This latter situation would clearly apply to lifting a large flat load to the side of the body.

Strength testing, although not directly indicative of injury risk, nevertheless provides a measure of the relative risk of overloading. Kumar and Garand (1992) presented a complex paper of lift strength testing data including asymmetric postures. The effect of trunk rotation was varied. However, there would appear to be some progressive loss of muscle strength with 30º or 60º lateral rotation, the effect being more marked when the load application is close to the body. The effect is even more marked in contrasting stoop lifting in the sagittal plane with bent-knee lifting with 30º or 60º asymmetry. The data clearly show a strength advantage with the symmetrical posture.

It is important to differentiate between the lifting whilst twisting, as studied by Plamondon et al (op cit) and twisting whilst actively lifting such as the work of Gagnon and Gagnon (1992) as the work of Marras and Mirka (op cit) showed this latter action to be particularly hazardous. Most papers on asymmetric handling have utilised protocols involving simultaneous lifting and twisting. However, the evidence of Plamondon and co-workers would seem to suggest that lifting whilst twisting should be avoided. The recommendation in lifting large flat, vertical loads would therefore appear that it is preferable to maintain trunk symmetry, lifting the load in front of the body rather than to the side.

8.5 LIFTING FROM A CONTAINER

Many of the studies cited in relation to one-handed lifting are relevant to lifting from a container. It is difficult to achieve any degree of knee flexion in lifting from a container, particularly from deeper levels. Although some lifting advisors are known to advocate putting one foot into the container in particular situations (e.g. lifting from a car boot) this is seldom practicable (or safe) with industrial containers and also results in holding the load and standing on one leg as the other foot is removed. In this instance, choosing between principles is not an option as the posture necessary is largely dictated by the lifting environment. The work of Plamondon et al (op cit) referred to in the previous section, would seem to counsel against any attempt to squat along the side of the container and lift with the trunk rotated. Practical advice such as pulling objects forwards as far as possible before lifting, based upon the principle of minimising the horizontal distance, would seem appropriate whatever posture is adopted.

Several delegates who participated in the Delphi exercise advocated bracing hands or knees against the container. As stated in Section 8.2 (lifting with one hand) it would seem preferable to lift with two hands if possible but, if circumstances prevent this, using the other hand as a support can be beneficial. However, if the hand is free for bracing then it will usually (but not always) be available for lifting.

Again as cited earlier, the work of Ridd (op cit) does show an advantage in using the knees to brace. Clearly, any advice to this effect must be tempered by the need to check that the container being braced against is firm and will not move away or collapse. Subject to this, the advice when lifting from a container would seem to be to favour getting the load as close as possible, flexing the back if necessary, rather than seeking to devise some posture allowing bent knees. One proviso to this would seem to be to emphasise the particularly hazardous nature of flexion to the full range of motion. The additional principle or advice to use the knees or legs to brace against the container would seem to be valuable guidance.

8.6 LIFTING IN LIMITED HEADROOM

The difficulty in lifting in limited headroom depends to some extent upon whether or not it is necessary to move with the load once it has been lifted as this influences the options available. The view of the experts was that the principles for normal two-handed lifting still applied although some suggested kneeling or other manoeuvres.

An early substantial study of lifting in reduced headroom was reported by Ridd (op cit). A series of stooped postures was examined, imposed by percentages of reduced headroom ranging from 97% to 66% of stature. Measures of intraabdominal pressure (IAP) were used as an indicator of trunk loading with a limiting criteria of 90mm Hg pressure. The results showed most of the reduction in capacity to occur with the first 10% of height restriction, with stooping to 90% or less of stature yielding a safe handling capacity approximately 40% of that in an upright stance. In contrast, accommodating a reduction in headroom of approximately 25% (75% stature) by kneeling on one knee and maintaining an upright trunk resulted in a reduction in capacity of only about 10%. Kneeling would therefore seem to offer a clear advantage over stooping in reduced headroom. Clearly however, if the load has then to be carried, kneeling is not a viable option.

The work of Ridd (op cit) constrained subjects to adopt highly stylised (feet together) postures. This issue was examined by Sims and Graveling (1988) who conducted a series of experiments simulating handling activities in free or restricted headroom, again utilising IAP. Comparisons were made of IAP levels performing a common mining task of loading and unloading bags of stone dust from a number of different vehicles. The three vehicle styles covered two flat-topped vehicles of differing heights and one vehicle with sides. The headroom chosen represented 84-94% of stature for the participating subjects (average 90%). The study found that the subjects (experienced miners) were apparently able to compensate for the influence of the reduced headroom in some way. Free to adopt any posture they chose, most stooped as the task included a need to walk a short distance carrying the bags. However, increases in truncal strain fell well short of the anticipated 40%, averaging the equivalent of a 7% reduction in safe working load (although the authors refer to considerable inter-individual differences). The authors noted that the constraints imposed by differences in vehicle style played a significant role with the high sided vehicle causing significantly higher peak IAP values. In addition, in a task involving moving bags between the two flat-vehicles and a roadside stack, reduction in headroom did not have a significant effect on truncal stress. It appeared that in the reduced headroom the subjects remained stooped throughout and that therefore the stooping to reach the vehicles or the roadside stack entailed less vertical movement in lifting. This may have accounted for the highest peak values being recorded during the free headroom element of the study.

Gallagher et al (1994) utilised an emg-assisted biomechanical model to examine spinal loading in lifting tasks in restricted postures, again utilising stooping or kneeling. The use of a one or two-knee kneeling posture is not specified although the illustrations imply two. The stooped posture was determined by the heights in the lifting task rather than any imposed headroom restriction, with lifts from the floor to a 350mm or 700mm high shelf. Kneeling produced significantly higher peak compression but lower lateral and antero-posterior shear forces. The authors attribute the changes in compressive force to the increased contribution of the posterior spinal ligaments in the stooped posture 'sparing' the muscles.

Predicted muscle forces are presented. However, the analysis of these revealed a complex posture x height x weight interaction making it difficult to generate any simple guidance on the basis of muscle loading. The higher spinal compression in kneeling rather than stooping is at odds with the finding of Ridd (op cit) as IAP has been regarded as a surrogate for intradiscal pressure. As an indication of the magnitude of the effect, Gallagher and co-workers state that differences in compressive loading indicate that lifting 25kg when stooped is equivalent to lifting approximately 15kg when kneeling. The significance of the two - versus one - knee stance is not known. However, from the illustrations it is apparent that the kneeling postures nevertheless required a degree of stooping or bending forwards whilst those of Ridd (op cit), illustrated in MHRU (1980), entailed an upright back. Those of Gallagher et al would therefore seem to be more realistic.

No attempt is made by the authors to consider the relative risk associated with these differences. Using previously cited limiting criteria of 3400 N (compression) and 1000 N (sheer) it can be calculated that, compared to stooping, kneeling results in a 22% increase in risk due to compression and a 10% decrease in risk due to shear. The average shear forces documented for either posture are less than 20% of the limiting criterion whilst those for compression are more than 50%. On this basis, posture selection should favour stooping over kneeling.

Earlier work by Gallagher (1991) which was conducted in a physically restricted headroom, found that kneeling resulted in an 11% lower lifting capacity than stooping when using a psychophysical approach.

Studies reported by Smith et al (1992) also utilised a psychophysical methodology to examine a wide range of non-standard postures including lifting whilst kneeling or squatting and lifting and carrying in reduced headroom. However, the latter element utilised a single standardised posture and therefore, whilst providing an insight into absolute capacity, does not allow any comparison of different postures for the same task. Comparisons of kneeling and squatting, in which it might be anticipated that shoulder height (and therefore lift height) was reasonably comparable, suggest that kneeling produced higher acceptable lift weights than squatting with little real difference between using one or two knees. However, weight adjustments were restricted to 2.25kg (5lb) steps which may have reduced the sensitivity of the study. No direct comparisons of stooping and kneeling (or squatting) were conducted. However, it is interesting to note that the lift and carry (3m) task in 60% of stature, resulting in 'very flexed trunk and knees' yielded higher acceptable weights than the static kneeling postures reported.

The limited extent of research information in this area, compounded by apparently conflicting results makes it difficult to produce definitive guidance. However, given the relatively stylised postures employed in the research by Ridd, the findings of Gallagher and co-workers that stooping is preferable to kneeling, would seem to be most applicable to practical handling situations. In most such situations, the load is going to be moved, not just lifted, and stooping clearly provides a more practicable option in such cases. It would seem therefore that the guidance should be to stoop, rather than kneel, whilst still adhering as much as possible to the fundamental principles. This would also seem to be appropriate when some carrying is required.

8.7 LIFTING WHILE SEATED

The numerical guidelines in the HSE guidance on the manual handling regulations (HSE, 1992 and 1998) advocate a significant reduction in lifting capacity when seated, with guideline values equivalent to the worst-case standing postures. The source of these data are not known. Early work by the Manual Handling Research Unit (1980) utilising IAP-based criterion, indicated much higher values with age-dependent figures for men ranging from 18-30kg within the box zone indicated (two handed lifting) or 16-25kg for one-handed lifting.

Also using IAP, Boudrifa and Davis (1987) examined the effects of lifting in twisted and/or forwards leaning postures whilst seated. Experimental conditions encompassed 45º twist to either side of the midline and lifting at arms length or at arms length plus 15cm or 30cm, requiring the subject to lean forwards. As might be expected, both variables increased the strain of lifting as indicated either by IAP or any of the erector spines in the opposing side (left erector spine, twisting to right). Precise numerical data are not tabulated, the results only being presented graphically. Nevertheless it is noted that mean IAP values, even for the worst cast (twisted, 30cm lean) did not reach the criteria of 90mm Hg for the 10kg load lifted and that the mean IAP for no twist, lifting 10kg at arms length, was only about 45mm Hg.

Not surprisingly, this study reinforces the guidance that, for lifting whilst standing, twisting or leaning forwards, increases the strain on the spine. An earlier study by Boudrifa and Davies (1984) showed that IAP levels when lifting whilst seated could be minimised by encouraging the lifter to utilise a back rest providing prominent lumbar support and extending up to the thoracic region. A backrest angle greater than 90º (100-110º) was also indicated. Given the number of industrial environments in which relatively rudimentary seats are provided this is valuable guidance. From data presented, it appears that 'best case' IAP values are some 60% of the worst case (in which mean IAP levels approach the 90mm Hg criterion).

Smith et al (op cit) documented studies of lifting activities whilst seated as part of their major report on non-standard postures. However, although providing guidance on absolute capacity no variations in sitting posture are reported.

Some differences in seated posture are reported by Yates and Karwowski (1992). The results indicate higher back muscle activity for lifting forwards (leaning) and lifting to the side (twisting) than for an upright static lift. This reinforces the fundamental principles of avoiding twisting and leaning (horizontal distance) when lifting, whatever the posture. Interestingly, there was no significant difference in low back emg values between lifting and twisting through 90º and lifting a load forwards to about arms length. However, the twisting action evoked a considerable increase in abdominal muscle activity suggesting that work place designs should advocate lifting loads forward away from the body rather than twisting to the side.

In essence therefore it would seem, again from limited data, that lifting whilst seated is best conducted with the trunk braced against a backrest providing support both to the lumbar and thoracic regions. A prominent lumbar moulding would seem to be advantageous. As with other forms of lifting it would seem to be reasonable to suggest (although no experimental evidence has been found to support this) that turning would be preferable to twisting and that, if this is not possible, moving loads forwards rather than twisting to the side would appear to be preferable.

8.8 LIFTING LIGHT LOADS FROM LOW DOWN

In lifting loads from low down the energy cost of 'leg lifting' is often regarded as a deterrent. Evidence cited earlier suggesting that load position is more important than posture would seem therefor to blur any perceived advantage of 'squat lifting'. However, a low load position implies a small load that could result in a fully-flexed back posture if stoop lifting was to be employed. Given the apparent hazard associated with this posture, coupled with the added risk if any twisting is performed whilst stooped, then it is suggested that the fundamental principles should be adhered to. These would seem to advocate a balance between flexible of the spine, hips and knees and, although a greater degree of spine flexion might be acceptable, the hazards of extreme flexion should be emphasised.

8.9 CARRYING LOADS

Much of the emphasis of research into carrying loads has been on the energy cost of differing methods of load carriage, rather than specifically on the risk of injury. Thus, Legg (1985) reported that the energy cost of carrying a box clasped to the chest was about 80% of carrying it in one hand with the arm fully extended. However, Bobet and Norman (1984), in a study of the placement height of a load carried on the back, found that although overall physiological cost (as measured by heart rate) did not differ, muscle activity was significantly different between the two load heights. Legg (op cit) suggests that local muscle fatigue is an important limiting factor in load carriage. For example, the author refers to back pack carriage in which discomfort in the back, neck or shoulder muscles is often the limiting factor rather than general fatigue. It can be hypothesised that this discomfort is a precursor to injury to the muscles affected. In addition, load bearing on structures of the body may give rise to injuries to that structure. Thus there are case reports (e.g. Hadley et al, 1986) of nerve entrapment caused by extensive backpacking. Thus, the focus on comparative energy costs of much of the scientific literature on carrying is unhelpful in establishing the relative risk of musculoskeletal injury. Returning to the review paper by Legg, it is interesting to note that carrying the load on one shoulder, a stance often adopted when carrying loads any distance, resulted in higher energy costs than clutching the load to the chest. The selection of shoulder carriage possibly therefore owes more to muscle fatigue effects than overall effort.

Many evaluative techniques employed to examine and compare the strain of lifting focus primarily on the dynamic loads during the accelerative phase of the lift. Thus, Davis (1981) describes how intra-abdominal pressure (IAP) varies with phase in the lift cycle, focusing on the initial peak coinciding with that accelerative phase. Thus, when Sims and Graveling (op cit) utilised IAP measurements during a lift, carry and lower tasks, they focused on the peaks at lifting and lowering rather than the elevated plateau during the carrying phase.

Kram (1991) reported the findings of carrying loads on springy bamboo poles, a technique apparently widely used throughout Asia. The author demonstrated a divergence between measurement parameters in that oxygen consumption was similar to that measured carrying similar loads with a backpack. However, peak shoulder forces and loading rates were minimised as was the peak vertical ground reaction force. Although the use of spring bamboo poles is unlikely to become widespread in British industry it again demonstrates the importance of not focusing solely on energy cost.

Bhambhani et al (1997) gave one example of how holding loads against the body can be advantageous beyond the energy cost criterion employed by Legg. Utilising load cells, the authors estimated that approximately 30-40% of the total load of a two handled box could be supported directly by the trunk in carrying rather than through the arms. This has clear implications both for reducing biomechanical loading (minimising load-spine distance) and reducing musculoskeletal strain on the arms. Presumably however, with a larger load possibly obstructing leg movement, the load distribution characteristics would alter.

Vacheron et al (1999) again reported that shoulder strain appeared to be the limiting factor for load carriage in a backpack. Interestingly however they reported that reducing stride length (and wearing appropriate footwear) reduced shoulder strain. Earlier work by Charteris et al (1989) of African women carrying loads on their head (headloading) demonstrated changes in stride characteristics that might be related to this.

A number of studies, such as those summarised by Legg (op cit) have often failed to demonstrate differences in energy costs between different forms of load carriage, presumably because, unless the working muscle groups differ significantly in efficiency, basic physics determines the energy needed to move a load. Lloyd and Cooke (2000a) however, did demonstrate an energy advantage of a rucksack with both front and back loading over a traditional back pack. It can be suggested that a rear-only backpack imposes an asymmetric load that has to be countered on top of the gravity based mass of the rucksack and that distributing the load front and back helps to balance this asymmetry. This suggestion is supported by the observations reported elsewhere (Lloyd and Cooke, 2000b) that forward propulsive force was significantly greater with the conventional rucksack.

Strenuous marching carrying a backpack is an extreme form of carrying. Quesada et al (2000) cite epidemiological studies that mainly indicate injuries to the lower limb (ranging from blisters to stress fractures) although low back strain also features in the list. Consequently, their experimental studies mainly focus on load factors for the lower limb. The outcomes identified problems with knee loading, seemingly attributable to excessive fatigue of specific muscle groups. The authors draw attention to the fact that this was despite the overall energy cost being within acceptable limits indicating that emphasis on energy costs could mask other hazards.

Measurements of spinal forces during backpack walking (Goh et al, 1998) indicated that such forces did not increase proportionately with overall load, apparently due to changes in walking posture (increased trunk flexion with increased load). Thus a doubling of load carried, from 15% to 30% of body weight resulted in an increase in lumbosacral force from 26.7% to 64% over unloaded walking.

This latter paper examined compressive loading. LaFiandra et al examined transverse loading (torque). According to the authors, unloaded walking is characterised by counter-rotation of the upper and lower body, reducing the net angular momentum of the body. Studies of loaded (backpack) walking indicated that, although higher levels of upper and lower body torque were observed, the increase in upper body torque was countered by a disproportionate increase in upper body moment of inertia. This was considered to reflect an innate control mechanism that would have the effect of minimising upper body torque, thereby reducing the likelihood of injury.

Shoaf et al (1997) reported extensive limits for a variety of manual handling activities including carrying. The limiting equations were derived from a combination of psychophysical and biomechanical parameters. As a psychophysically derived load may at least partly reflect local muscle fatigue rather than overall body load this may have some merit. However, the biomechanical criteria were based upon spine compressive force which might not be the most appropriate. In addition, the equations appear to be restricted to the single method of load carriage using a two-handed grip on a tote box.

The issue of cumulative, rather than peak, spinal loading is addressed in a paper by Callaghan et al (2001). Illustrations show twin peaks of compression associated with the dynamic lifting and 'placing' phases, equivalent to the description of IAP patterns by Davis (op cit). However, in this instance the analysis is restricted to a lifting activity with no load carriage phase. In addition, no reference is made to injury risk criteria against which task loading could be evaluated.

In conclusion, many studies of load carriage rather than lifting have focused on overall energy cost criteria which may not bear a close relationship to injury risk. Reduction in intervertebral disc height is seen as being related to cumulative loading and to risk of spinal injury. However, no studies of load carriage rather than repetitive lifting have been found which address this issue.

There are indicators in the literature that muscle loading and hence fatigue is a strong determinant of load carrying capability. A logical corollary to this is that excessive muscle loading or sustained fatigue can increase susceptibility to muscle injury. Direct local compression of body parts, particularly the shoulder but also possibly the hands (especially with poorly designed handles) is also likely to present a risk of injury. However, no documented studies have been found that would provide additional principles for load carriage. It would therefore appear likely that, to the extent which the existing principles reflect an intention to minimise muscle loading (e.g. distance of the load from the trunk will influence trunk muscle loading as will torsional loads) these same principles apply to load carrying as well as lifting. However, these should be tempered to the effect that any method of load carrying, particularly over long distances (or for extended durations) should take into account the possibility of local muscle loading and fatigue.

8.10 CONCLUSIONS

It is apparent from the literature summarised above that, although little scientific evidence exists in relation to specific studies of different handling techniques there is sufficient material to provide the basis for guidance on selected 'non-standard' lifting situations. This material, together with comments made by individual experts, was used to develop the guidelines presented in Section 9.3.

9. THE FINAL PRINCIPLES

9.1 INTRODUCTION

The Delphi exercise and the further consultations with trainers and others with a professional interest in manual handling resulted in a sometimes bewildering collection of phrases and alternatives to present the underlying scientific principles. Each issue will be briefly summarised in turn and suggested wording presented. In each case, the final text suggested is presented in a box, with the principle in **bold**, followed by the supplementary text. In virtually all cases it is assumed that the principles will be presented with some explanatory text, removing the need for the entire message to be presented in the 'strapline'. The text presented below also incorporates some suggestions made when the draft text was circulated within the HSE.

Although warming-up had initially been suggested by some of the Delphi delegates, the absence of any scientific support for this from the literature means that it has been dropped from the list.

9.2 TWO-HANDED SYMMETRICAL LIFTING

9.2.1 Plan and prepare for the task

The two principle statements caused some confusion amongst handling trainers although once the distinction was explained between planning the handling task and preparing for the lift itself then the importance of these two concepts was readily accepted. The current text of L23 uses the strap line 'stop and think'. This implies actually standing and looking at the load, an activity that might not always be acceptable (or necessary). For this reason 'think before you lift' is suggested as an alternative.

The current accompanying text offers sound advice that reflects the essence of the discussions during the course of the project. An additional sentence such as 'Think about the best way of lifting this load' may be beneficial. Clearly it would be possible to present much more useful advice at this stage, such as considering splitting the load etc. However, a balance must be struck between presenting sufficient information and overloading the reader.

Think before you lift. Plan the lift. Where is the load going to be placed? Use appropriate handling aids if possible. Do you need help with the load? Remove obstructions such as discarded wrapping materials. Think about the best way of lifting this load. For a long lift - such as floor to shoulder height - consider resting the load mid-way on a table or bench in order to change grip.

9.2.2 Minimise the horizontal distance

The full text of this principle from the Delphi meeting:

'Minimise the horizontal distance between the lower back of the handler and the centre of gravity of the load throughout the manual handling operation'

is undoubtedly correct but was seen by the trainers as being impractical as a strapline. Apart from the greater detail over 'keep close to the load' the additional text reflects ideas within the existing L23 text i.e. 'for as long as possible' and 'throughout the manual handling operation' and 'keep the heaviest side… next to the trunk' and references to the centre of gravity. The intelligibility of phrases such as 'minimise the horizontal distance' and concepts such as the centre of gravity of the load must be questioned.

'Keep the load close to your waist' whilst not as scientifically correct, will have the desired effect in most cases and the use of the work 'keep' helps to emphasise that it is not just at the start of the lift. It is suggested however that some explanation of why would be valuable here such as 'The distance of the load from the spine at waist height is an important factor in the overall load on your spine and back muscles'. This could be used to supplement the existing advice in L23.

> **Keep the load close to your waist.** Keep the load close to the trunk for as long as possible. The distance of the load from the spine at waist height is an important factor in the overall load on your spine and back muscles. Keep the heaviest side of the load next to your body. If a close approach to the load is not possible try sliding it towards you before attempting to lift it.

9.2.3 Create and maintain a stable base

The essential elements of adopting a stable posture at the start of the lift and that this should be capable of being changed during the course of the lift in order to maintain stability are not in question. Once again however, the exact presentation of these elements was the subject of much debate. Some felt that 'maintain' implied 'keep like that' i.e. a fixed position. The alternative, proposal in the follow-up, using the word 'stance' was also perhaps not ideal. Words such as posture or position might be less exact but more readily understood.

> **Adopt a stable position.** Have the feet slightly apart with one leg slightly forward to help maintain balance (alongside the load if it is on the ground). Be prepared to move your feet during the lift to maintain a stable posture.

9.2.4 Get a secure hold

There was a broad consensus on the merits of 'hold' over 'grip' although not everybody thought it to be an important distinction. The wording proposed by the trainers seemed better. There have been a number of studies relating to the position and design of handles. However, not all loads will have handles and, in some that do, the handles may be a very poor design. Consequently, it is not suggested that any reference specifically to handles is included.

> **Ensure a good hold on the load.** Try hugging it close to the body if possible. This may be better than gripping it tightly only with your hands.

9.2.5 The lumbar spine, hips and knees should be moderately flexed (bent) at the start of the lift.

Again, there was much discussion in all meetings about the significance of this principle and of the best wording. This is important as the inclusion of flexing the spine represents a notable deviation from the previous advocacy of a 'straight' back. There was general consensus that extreme flexion of any of the joints (for example a full squat) should be avoided. The contribution of research into the biomechanics of the spine to understanding spinal loading is important here. General consensus was that a positive principle 'should be moderately flexed' was preferable to the negative 'don't over flex'.

The alternative phrasing, particularly the use of the term 'soften or relax' was liked by some trainers but may not be readily understood by those adopting a different handling 'philosophy' and cannot therefore be accepted. As this is a vital element it is considered that a longer strapline is necessary.

At the start of the lift, moderate flexion (slight bending) of the back, hips and knees is preferable to fully flexing the back (stooping) or the hips and knees (squatting).

9.2.6 Don't flex the spine any further as you lift

Observing 'traditional' lifting with the legs it is apparent that some people 'lead' by beginning to straighten their legs first. If this does not coincide with raising the load then the hands remain at the same height and the back must be flexed further to compensate. A suggested explanation to avoid this is given below:

Don't flex your back any further as you lift. This can happen if you begin to straighten your legs before starting to raise the load.

9.2.7 Try not to twist the trunk or lean sideways, especially while the back is bent.

The scientific evidence clearly indicates that combinations of forward and lateral flexion with rotation during the actual dynamic lift phase when compressive forces are maximised are particularly hazardous. As all of these principles could be prefaced by the words 'Try not to..' or 'If possible ..' the use in this case seems unnecessary.

Avoid twisting the trunk or leaning sideways, especially while the back is bent. Keep shoulders level and facing in the same direction as the hips. Turning (by moving the feet) after lifting is better than twisting and lifting at the same time.

9.2.8 Keep your head up when handling

Conventional thinking has been that looking ahead rather than down at the load aids in adjusting the shape of the spine, helping to at least partly restore the lumber lordosis. Other lifting and handling philosophies see leading with the head (e.g. 'forces which are always initiated by movement of the head in a cephalad direction', Crozier and Cozens, 1997) as fundamental. In contrast, advice based on the biomechanics of the spine suggests that this is less important than previously thought. This resulted in it being accorded a low overall priority amongst the Delphi experts.

Keep your head up when handling. Look ahead, not down at the load once you have grasped it and secured it.

9.2.9 Move smoothly

This was seen as more positive guidance than the current 'don't jerk'. Lifting smoothly as a concept was acknowledged as important, both by those who advocate a flowing lifting style and by the research which has demonstrated the detrimental effect of rapid acceleration of a load.

Move smoothly. Try not to jerk or snatch at the load as this can make it harder to keep control of the load and can increase the risk of injury.

9.2.10 Don't move more than you can easily manage

There was some question as to whether or not individuals had a clear idea of their own limits. Nevertheless there was a consensus that this was good advice. There was some debate over the use of the word 'easily' although omitting this could be seen to advocate lifting up to the limit of what can be physically lifted.

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Don't lift or handle more than you can easily manage. There is a difference between what you can lift and what you can safely lift. If in doubt, seek advice or get help.

9.2.11 Put the load down, then adjust its position

This factor was not discussed at any length during the Delphi meeting. However, responses prior to the meeting indicated unanimous agreement amongst those replying at that stage. The following text therefore duplicates that from the second edition of L23.

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Put down, then adjust. If precise positioning of the load is necessary, put it down first, then slide it into the desired position.

9.3 OTHER FORMS OF LIFTING AND CARRYING

9.3.1 Introduction

The consensus amongst the experts was that the principles for good (safe) manual handling determined for two-handed symmetrical lifting were fundamental principles that were equally valid in other forms of lifting. However, it has to be acknowledged that it is not always possible to follow all of these principles. The following sections give some guidance on priorities in different forms of handling. Although a strong consensus was not apparent from the responses of the experts following the Delphi exercise, three principles almost always emerged as having the strongest support. These were **'Plan the task' 'Minimise the horizontal distance'** and **'Get a secure hold'**.

9.3.2 One-handed lifting

When lifting in front of the body, lifting with two hands is preferred. However, if lifting to the side is unavoidable then lifting with the hand on that side is preferable to twisting to use both hands.

9.3.3 Large bulky loads

Keeping the load close to the body is more important than bending the knees. However, the instruction to avoid extreme flexion is still valid.

9.3.4 Large, flat vertical loads

Lifting the load with two hands at the side of the body involves twisting and lifting which should be avoided, even though it may allow the knees to be bent. Such loads should therefore be lifted in front of the body, stooping slightly if necessary. If the load is to be carried any distance, lifting in this manner and then moving the load round to the side is preferable to lifting at the side.

9.3.5 Lifting from a container

Getting the load as close as possible to the body is more important than avoiding all but complete flexion (stooping) or bending the knees. If safe to do so, leaning (bracing) against the side of the container will be beneficial. Bending the knees and twisting to the side is not to be advocated. Placing one foot in the container results in a period of standing on one leg whilst holding the load and should therefore be avoided.

9.3.6 Lifting in limited headroom

Except in extremely limited headroom where complete flexion would be necessary, stoop lifting, following the other principles as much as possible, is preferable to kneeling.

9.3.7 Lifting whilst seated

Because, when seated, movements such as twisting, leaning forwards or lateral bending all primarily involve the spine (unlike standing where, for example, some hip rotation is possible with twisting) then adherence to the basic principles is even more important. There is evidence that use of a backrest can reduce the load on the spine when lifting. This would seem to be in addition to the constraints imposed on undesirable movements by using the backrest.

9.3.8 Lifting light loads from low down

Bending the knee to lift light loads, particularly in a repetitive manner, is believed to place disproportionate loading on the knees in relation to the extent of any risk. The 'new' basic principle of moderate flexion in back, hips and knees and the exhortation to avoid extreme flexion of any joint are equally valid here and should enable a suitable technique to be adopted.

9.3.9 Carrying loads

Criteria for optimum carrying techniques are based primarily on energy cost, not injury risk. The consensus from the literature suggests that local muscle fatigue and other body part loading (e.g. straps on shoulders) provide more appropriate criteria. Discomfort and fatigue present reasonable early warnings of excessive local loading and possible injury risk. Techniques which minimise this, or systems of work that allow changes in carrying technique would appear to be desirable.

9.3.10 Team lifting

Planning the lift and having a good hold will clearly be particularly important in team lifting, as reflected in the responses following the Delphi exercise. Further guidance will reflect the nature of the load being lifted. Where the characteristics of the load and the lifting environment permit, adherence to the principles for two-handed symmetrical lifting will optimise the technique. However, where the nature of the load precludes the use of this technique then the guidance appropriate to the nature of the load should be applied.

ACKNOWLEDGEMENTS

The authors would like to sincerely thank all those who contributed to the discussions that formed the basis of this research, specifically those who took part in the focus group meetings, and the researchers who generously provided of their time and expertise to help form the consensus. We would also like to thank our HSE project supporters: Mr Malcolm Darvill, Dr Claire Dickinson, Mr John McElwaine, Mr Len Morris and Mr Chris Quarrie for their help and guidance during the research.

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Appendix 1: Difficult loads / environments for handling

No.	Type of problem
1	Large flat(ish) loads that have to be picked up and held horizontally flat (e.g. trays of fruit and veg lowered into shelving system in supermarkets) and away from body (e.g. radiotherapy units, trays of hot food)
2	Large flat load (can be held vertically), requiring arms to be spread when holding it, possibly obscuring vision, and restricting ability to walk (pictures, doors, panes of glass).
3	Loading into / from crates (can't bend knees due to edge of crate); same problem loading into car engine (e.g. battery)
4	Heaviest part of load is held away from body e.g. when using a spade (digging, spreading gravel). Similar problem with scooping custard from a large, deep vat.
5	Loads that have to be lifted and inverted before placement (e.g. bottles for water dispensers)
6	Lifting when precise placement of load does not matter (e.g. throwing refuse sacks, laundry bags)
7	Delicate large loads with no hand-holds, requiring precise placement (e.g. glass lid of display cabinets)
8	Positioning and removing an item into/from a confined space (e.g. white goods in kitchens)
9	Handling in confined space where there may not be room to squat, or face the load square-on (e.g. handling patients in bathrooms; electricians working in holes)
10	Handling with limited headroom e.g. inside back of van
11	Picking up sacks – weight may shift. *Should the hands be underneath (flat palm) or gripping at top?*
12	Rolls e.g. carpets. *Is it better if they are handled under the arm or on the shoulder?*
13	Handling close to the ground – *is it better to kneel or crouch? Use one hand as a brace or lift with two hands?*
14	One handed lifting (e.g. bucket*) – lift at side by bending or semi- squatting, or lift in front of body?*
15	One handed carrying *(e.g. laptop – is it better to carry in the hand or wear a strap on the shoulder? If so, which shoulder? Is it better to carry to the side of the body, infront or on back?)*
16	How to carry a load between two people (e.g. walk forwards / backwards or sideways); both when walking on flat, and on stairs
17	Handling on stairs – should acceptable weight lifted be reduced?
18	Handling through confined access spaces (e.g. car assembly, assisting people within vehicles, children into child seats)
19	Loads where it may be difficult to get a good hold (e.g. some patients)
20	Unpredictable or uncooperative patients
21	Assisted walking with small patients – *should handler be at side or in-front?*

Appendix 2: Handling issues identified in workshops

Summary of discussions

In the discussions it was intended that difficulties which could be addressed through improved load, task or workplace design would not be the main focus; rather that attention was paid to handling situations where little could be done to alter the load or the handling environment, and awkward postures may therefore result. However, it became clear that in many situations, while steps could have been taken to re-design the load, task or environment, or lifting equipment could have been provided, there were reasons why this had not happened, e.g. poor communication, lack of management commitment or resources etc. Many of the situations outlined therefore forced awkward postures. One clear message from the groups was that there was a need for management commitment to these issues for any changes (e.g. design task, load, environment, or provide handling equipment) to be implemented effectively.

Difficult handling scenarios

Inevitably, many difficulties mentioned by delegates were due to a combination of factors. The summary below classifies the difficulties into broad categories depending on the reason for them.

Fundamental questions where definitions / discussion need to be clarified:

- A distinction should be made between the biomechanics when lifting and when carrying as different factors may need to be considered.

- Are handling principles different if carrying over short distances compared with long distances e.g. placing the load on the back (e.g. backpack) may not be biomechanically efficient for short distance carrying. Different guidance is likely to be required.

- Discussion of type of hand grip... (and also whether the use of the word 'grip' is useful)

- Discussion of position of hands on a load.

- Handling while negotiating obstacles – should we be discussing this? – if the route were planned appropriately this would not be required, but if carrying over a long distance it will not be possible to prepare the route all the way; and in many observed situations, people do not plan their route appropriately. Would it be better to put something down, then open the door, then pick it up again, or to try to open it while handling?

- What to do when you can’t stay in the area of your base - is this the most important principle?

Load size / shape / weight / other characteristics

There may be one, or a combination of several, characteristics of the load which make it difficult to handle. Factors include sizes, shape, characteristics of surface, delicacy of load or contents, stability of load or contents, as well as weight of load. Many examples were given of non-live loads, and these are summarised below.

- Flat, large rectangular loads that are oriented vertically e.g. panes of glass, pictures, flat pack furniture. They may be wide, requiring a complete arm-span to hold them; or hands could be placed underneath the base. The thin depth may make them difficult to hold, particularly if they are heavy. They may not have to be held vertically all the time they are lifted / carried, and this may allow a greater variety of carrying positions.

- Large rectangular loads of thin depth that are oriented horizontally and have to be kept that way. e.g. trays of food; trays of fruit and vegetables in supermarkets (weight approx 18kg). They may be lifted from the floor, and it is not possible to get them within the envelope of the legs; Placing these trays into the shelving also involves some leaning and stretching, beyond the operator's base. The load is often greater than shoulder width.

- Large rectangular deep loads where the depth may interfere with walking (if the load is carried).

- Large loads, where the size of the load prevents the handler bending at the knees as would have to lift the load past the knees – thus requires bending at the hips.

- The size of large loads may mean vision is restricted, possibly forcing awkward neck postures to allow the operator to see (as well as increasing the risk of an accident).

- Rolls e.g. carpets, cloth, polythene or paper. These are often relatively long and moderately wide. If they are carried (i.e. over a distance), this may be on the shoulder; they then need to be lifted onto the shoulder.

- Loads whose shape may alter as they are lifted, e.g. sacks of flour, soil etc. It can be difficult for the operator to get a good hold.

- Load may be unstable e.g. pile of books; medical files which may fall apart, meaning additional hand grip may be required to hold the load together.

- Load may be delicate, heavy, difficult to hold e.g. Winchester containers with liquid chemicals (which themselves may be dangerous); musical instruments; museum exhibits.

- Load where the centre of gravity has to be held away from body e.g. spade where weight is away from the handle. In this situation, the operator will usually use their second hand to hold part of the handle that is closer to the load. This may require awkward postures; there is also usually some movement of the trunk involved to move the material. Also scooping food e.g. custard from containers – load is some distance from hand, and it may not be possible to hold the handle further down for hygiene reasons (and to avoid burning).

- Load may be fragile e.g. glass case for museum exhibit – this example is also large, has no hand-holds, and is not solid (no base).

- Loads that have to be held away from the body so the handler can avoid contamination or damage from the load e.g. Hot saucepans, hot trays of food lifted from ovens, box containing radioactive material, sacks of refuse, hospital laundry, limb support in surgery. Often these loads are large / heavy too.

- The surface of the load (hand-load interface) may make it difficult to hold, for example if it is delicate, sharp, irritating to the skin e.g. patients, panes of glass, hessian sacks. Handling can also be difficult when wearing gloves as they can decrease the effectiveness of the grip, meaning the operator may have to grip more tightly.

- The shape / nature of the load may make it difficult to hold e.g. overfilled sacks, loads with no handles.

- Live loads may be aggressive or unpredictable

Specific questions:

- What is the best way to grip a small but heavy sack e.g. containing coins – impact (on musculoskeletal system) of power grip, flat palm hold etc?

- Is it best to pick up loads with handles using one hand or two?

Handles

There was debate about handles, and the effect they have on lifting and carrying.

- Carrying a load in a bag with a shoulder strap; should the strap be over the shoulder at the same side as the load, or on the opposite shoulder.

- How to get a good hold on loads that have no handles; should advice be give as to where the hands should go.

- Handling loads that have handles (can mean they are lifted and carried with one arm, rather than held against the body). One example is with a bucket, where the handle usually means it is carried in one hand at the side of the body. It may be better biomechanically to hold it with two hands at the front.

Load and environment

- Manoeuvring a load into / from a confined space where it is only possible to have access from one side e.g. pushing white goods into / from a designated location within a kitchen; installing a boiler inside a cupboard.

- Carrying long / large loads around corners (e.g. in corridors) or through (narrow) doors. This may require alteration in hand position, adoption of awkward postures to negotiate this obstacle.

- Lifting a load from the floor or low down e.g. moving drain covers, lifting a small child / baby, a patient who has fallen.

- Placing a load into a hole e.g. electric / water equipment, pumps, coffins, poles; The operator needs to maintain a stable footing while lowering the load, so may not be able to keep the load close to the body. A similar problem arises when lifting loads out of holes; operators may have to climb into the hole to be able to get underneath the load and then lift it.

- Where it is not possible to get close to the load even if handling at approximately waist height e.g. lifting out of the back of a vehicle. Manual handling injury may still occur even if sliding the load closer to the body.

- The operator is not able to bend their knees (and thus has to bend their hips) when lifting loads into / out of a container with sides that extend past the knees e.g. lifting mail sacks from a truck (bucket style), cage or crate, lifting out of the back of a car boot. Is it best to use 2 hands to lift, or one hand to brace against the other side of the container? Is it advisable to brace the knees against the side of the boot? What about contact pressure on the knees? If this were a two person lift would it be better to lean into the boot sideways?

- Lifting a load up and out of a container e.g. goods out of boxes – so may have to raise arms to lift the load over the edge of the container.

- Lowering - i.e. handling a load to a low point e.g. loading a wheelbarrow – operators are likely to bend at the hips to lower, rather than at the knees.

- Lifting a body (or other load) out of the water results in an alteration in weight of the load as it is lifted out of water.

- Where the load has to be lifted over obstacles e.g. carrying equipment over fences / uneven ground.

- Lifting child and buggie onto / off bus.

- Spray painters; lying on their back, and having to hold spray gun above them?

- Carrying the load over a distance, where it may not be possible to plan the route e.g. some emergency situations, rescuing people.

- Pulling a load e.g. sheets of pliable material (e.g. paper) - walking backwards, load dragging on ground; may have to move obstacles out of way while pulling.

Emergency situations

Many of those who were involved with patient handling raised the issue of handling in emergency situations. In these situations it may not be possible to plan the route, fully assess the risks. Specific examples were:

- Handling of patients from outdoor environments (by the emergency services).

- Handling patients to evacuate a building; may not be possible to handled in the traditional way (e.g. if post-operative).

- Handling an aggressive patient / prisoner whose actions are unpredictable. Handling for restraint is very different to patient handling.

Handling combined with other tasks

- Handling a load and holding it in position while attaching it in place. For example, changing a wheel on a large vehicle; it needs to be lifted off the ground and then offered vertically to the axle, and aligned with the nuts; also hanging pictures on a wall - there may additionally be limited finger room around the back of the picture when holding it against the wall. Other examples include assembly inside vehicles (cars, ships), where the op may be in confined space as well as lifting the load (sometimes to overhead). They may need one hand to operate a tool to attach the unit in place, while using the other hand to support the load.

- While handling patients (holding / supporting) it may be necessary to undertake some other tasks e.g. administering suppositories. These types of handling can be difficult to do alone, but in some situations this is required.

- Lifting then needing to invert the load e.g. changing water bottles on dispensers, where they are usually picked up by the neck, which is the part that has to be placed into the machine. Hand grip may have to change.

- Lifting and also throwing the load e.g. refuse sacks, laundry sacks.

Environment

- Working in confined spaces where there may be limited headroom, so may have to handle in stooped posture e.g. handling inside back of a van, storage areas under the stairs, working under the floorboards.

- Working in confined spaces where there is limited potential to position the feet or hands appropriately relative to the load i.e. not possible to get close to the load. (e.g. lifting a patient who has fallen to the floor in a toilet).

- Lifting from a container where it is not possible to get the feet close to the load (e.g. stretching across a container to lift out an item; reaching across a deli counter to lift a tray of food before weighing out some produce).

- Carrying a load up stairs. The effect of the stairs will be affected by the size / shape / weight of the load. Many examples of carrying a load up/down stairs were given e.g. carrying television cameras to the top of a sports stadium.

- May not be possible to create a stable base if the surface is uneven, slippery, gravel, ice, wet etc.

- Handling while on a ladder.

- Need to stress that a stable base may be foot-knee; knee-knee-hand, not necessarily foot-foot.

- Not always possible to face the intended direction of travel when starting a manual handling operation e.g. if pulling a load from a confined space (e.g. removing fridge from kitchen).

- Not always possible to use lifting equipment, e.g. ambulance personnel handling in homes – patient may have collapsed in an awkward posture / environment where lifting equipment cannot be used.

Layout / organisation

- Storage of items in inappropriate places or poor planning e.g. on high shelves, behind other items etc, meaning double handling is required.

- lifting overhead (e.g. into an attic) poses increased risk of injury.

- Planning – over-ordering of stock at the end of the financial year may mean things are not stored in ideal locations.

Equipment

- In many situations, appropriate handling equipment may not be provided; due to cost constraints it is not possible to immediately replace equipment that is not ideal.

- Recognition that if equipment is not working or maintained properly it may introduced a new risk or increase the risk of injury e.g. if wheels stick on trolleys / hoists increased force may need to be applied.

- Support strap / harness that was used to lift a load between two people – don't often see any more.

Individual

- Individuals with knee problems may be unwilling to bend their knees, so tend to bend from the hips instead.

- Fatigue may develop if operators work long shifts; as a result, it is possible for errors / misjudgements to occur which result in injury.

- Lone workers may be forced to handle alone, increasing their risk of injury.

- It is important to recognise that those who are carers do so because they care; it can be understandably difficult to get people to comply with good lifting principles when these appear to be counter to the care of the patient. For example, putting a child in the middle of a bed, the handler will tend to cradle them in the arms, meaning they may have to adopt awkward postures.

- In guidance, need to recognise that therapeutic handling is different from manual handling.

- Also need to recognise that handling for restraint is different from manual handling.

- It is difficult to ensure that untrained visitors (e.g. parents) do not help with handling; there is concern over what happens if they get injured.

Team lifting

- Can be difficult to co-ordinate between people.

- It is not usually possible for the front person to walk forwards when handling up stairs.

Task

- Repetitive handling e.g. unloading materials from vans.

- Static postures e.g. stooping when handling.

- When the body moves in a direction that is counter to the movement of the joint e.g. walking backwards / sideways.

- Trade off between weight and frequency of handling.

- Lifting from deep squatting may mean you do not have a stable base (most people cannot get their feet flat on the floor when deep squatting).

- One handed carrying (e.g. laptop) – is it better to carry with one hand, or have the strap over the shoulder? If carrying in one hand is it better to use the dominant or non-dominant hand.

- Handling close to the ground – is it better to kneel or crouch? giving a two, three or more point base? E.g. foot-knee and hand or should it be two handed handling?

- Is it better in some situations to have one foot higher than the other – e.g. to put one foot inside the boot of the car to get closer to the load? or does this cause greater twisting of the spine?

- Handling while seated e.g. leaning and twisting to get bags of coins from drawers in the desk – is it better to lean forwards or to the side?

- What is the impact of carrying on the shoulder?

Clothing / PPE

- Handling when wearing gloves alters the hand-load interface, and may mean greater force is applied by the muscles to hold the load securely.

- Wearing airsuits (which can be very bulky) can mean any load has to be held away from the body.

- Wearing an airsuit means the wearer will have to bend the knees when handling as bending at the hips will result in them banging their head on the inside of the visor.

Patient handling

Many of the delegates were involved with some patient handling; there are particular needs and concerns in this area. Specific issues relating to handling patients include:

- It is not possible to reduce the load, so some handling is likely to still occur.

- Static handling of patients e.g. preparing a limb for surgery; the limb may have to be held in place for prolonged periods.

- Characteristics of a patient's condition may mean their body has to be handled with particular care. e.g. delicate skin, fragile bones.

- Equipment used in treating patients may make handling more difficult; e.g. equipment attached directly to the patient, which has to be moved with them.

- The need to maintain the dignity of the patient at all times.

- The need to encourage independence for the patient, so encouraging walking rather than lifting wherever possible.

- It is often difficult to control the environment in which handling is done, particularly in the community, so awkward postures may be forced due to lack of space, inappropriate furniture, lack of suitable equipment.

- Time pressures meant that correct handling techniques are not always applied (or equipment used); however, there was a recognition that application of an appropriate principle (e.g. get load as close to the body as possible before lifting) should not take any (or much) longer than not applying the principle.

- It was also commented that in emergency situations it can be difficult for the handler to undertake a suitable risk assessment, or to apply correct handling techniques.

- Inappropriate equipment may be bought e.g. because it is cheaper, but may not reduce the manual handling risk e.g. Japanese beds bought which were lower than the trolleys used, so handling of patients required to move them from the bed to trolley.

- People may not comply with good manual handling principles due to time constraints e.g. do not make a suitable risk assessment.

- In emergency situation the handling training may be forgotten.

- Removal of bodies from water – difficult to hold load, also unstable base of surface (boat).

- Animal handling over / within obstacles e.g. lifting police dogs over high fences; removing cattle from containers.

- Handling patients from a low position e.g. floor, bath etc.

- Handling patients where there may be some need for restraint as well as handling.

- In an emergency situation there may only be one person who is available to move the patient / casualty.

- Handling a person into a confined area e.g. putting a child into a car seat – need to reach through the door

- Need to communicate with patient / child so they can co-operate as far as possible.

- Assisted walking – is it better biomechanically to stand in front or at the side of the child?

Difficulties in providing training

There was also some debate about the effectiveness of training, and recognition that it was only part of the risk reduction process. However, many delegates commented that it was seen as the answer to manual handling issues by non-experts.

Content of training

- Training provided by those who attended the meetings is generally more in informing trainees of how to assess risks and then how to select the appropriate risk reduction measures, rather than in techniques of handling.

- There was concern that there is a lack of standardisation in MH training.

- There was some frustration about the whole context in which training was provided; it is possible to inform handlers of appropriate principles, and how to implement those principles (e.g. what technique to adopt) but often the handler or those responsible for manual handling have very little control over adapting the environment or load.

- Concern over making training realistic. For example, with patient handling, is it appropriate to train using live patients (or others)? How can you simulate a realistic handling activity without introducing a risk?

- Importance of undertaking risk assessments needs to be stressed, and individuals doing a risk assessment, and re-assessment if control measures are put in place.

Who to train

- There are management issues in ensuring that all personnel are trained, e.g. temporary workers, those carers who have limited language or other abilities.

- Due to work pressures it can be difficult for staff to be released from operational duties to be trained.

- There was some concern that running training courses encouraged people to handle, rather than trying to avoid handling.

- Some concern that those who may only handle occasionally (e.g. in offices) may not be given training or may not remember to apply it.

Facilities

- Suitable training facilities may not exist.

- Handling equipment may not always be suitable for use in homes; often inappropriate equipment is bought, and then cannot be used.

- Storage of handling equipment when not in use (particularly patient hoists).

Culture of handling / management

It was clear that many of the problems encountered with trying to apply the principles laid out in L23 were to do with the management systems and communication needs rather than the design of the load, environment or task. Specific points included:

- Within the healthcare sector, the culture is to lift people (patients often expect it); although this is changing there is still a need to more widely alter this perception.

- There was a frustration that the issue of manual handling was not taken seriously at a high level within NHS Trusts. External pressure was thought to be needed to alter this.

- It was thought that information was needed on the costs and benefits of manual handling policies / equipment / training and of back injuries in order to persuade management to take this seriously.

- Providing training is often the response given within the healthcare sector to the need for manual handling, but delegates questioned its effectiveness.

- There was a general feeling that the good manual handling principles are not currently being widely applied.

- A number of people suggested that training in appropriate handling (and posture) be given at school, starting with quite young children, and continuing throughout the education process.

- The importance of *avoiding* manual handling needs to be ingrained into the culture.

- There was a recognised need for manufacturers to consider the delivery of their product – stressing the importance of communication between all those involved in load design and handling.

- There was a recognition and concern that some people may be resistant to 'new' training techniques, or unwilling to change their behaviour.

- There was also an awareness of the cost of handling equipment / cost of re-design measures which delegates recognised may prevent them being implemented.

Culture of patient handling

- It is important to recognise that those who are carers do so because they care; it can be understandably difficult to get people to comply with good lifting principles when these appear to be counter to the care of the patient. For example, putting a child in the middle of a bed, the handler will tend to cradle them in the arms, meaning they may have to adopt awkward postures.

- In guidance, need to recognise that therapeutic handling is different from manual handling, so different guidance may be needed.

- Also need to recognise that handling for restraint is different from manual handling, so different guidance may be needed.

- It is difficult to ensure that untrained visitors (e.g. parents) do not help with handling; there is concern over what happens if they get injured.

- Time pressures meant that correct handling techniques are not always applied (or equipment used, or risk assessments undertaken); however, there was a recognition that application of an appropriate principle (e.g. get load as close to the body as possible before lifting) should not take any (or much) longer than not applying the principle.

Reasons for difficulties

All delegates were aware of difficulties in some manual handling situations. The reasons for people handling awkward / heavy / bulky loads in poorly designed work areas or with task constraints are usually due to wider issues. Reasons for this were:

- Poor workplace design meaning poor postures were forced when handling.

- Lack of participative approach in designing work environments, planning tasks / loads etc, meant that handlers have to adapt to poorly designed loads / tasks / environments.

- Lack of commitment or interest of management, so lack of time / resources to avoiding manual handling

- Some of those working as experts within their organisation felt that their views were ignored, whereas if the same advice was given by an external consultant it was taken more seriously and implemented.

- It was difficult to make handlers change their behaviour; they do not always comply with best practice. This may be for a wide range of reasons, including social and cultural constraints.

- Some thought that individual differences between people were the major factor why people do not handle appropriately; they were not able to comply with the principles.

- PPE may restrict movement, grip, vision. There can be a conflict between the need to provide protection and the need to handle.

Presentation of principles

Although not specifically intended as part of the workshop, there was some discussion concerning the principles currently outlined in L23. Particular suggestions for the presentation and content of the principles are that they should be:

- Clearer (e.g. what do the following mean: 'keep your back straight, maintaining its natural curves'; 'bend the knees so that the hands when grasping the load are as nearly level with the waist as possible'; 'if the hands are below knuckle height….')

- Some disagreement with the statement: 'Bend the knees so that the hands when grasping the load are as nearly level with the waist as possible'. May be better to talk about 'bending your knees a comfortable amount'.

- Specifically, some people wanted more emphasis on 'leading with your head' when lifting.

- Wanted emphasis on avoiding being in a locked position.

- Some delegates did not like the concept of having the leading leg as far forward as is comfortable as this may result in them becoming unstable. They favoured the idea of maintaining a balanced base.

- Would like emphasis on a stable base not necessarily being foot-foot; it may be foot-knee; knee-knee-hand etc.

- Some delegates would like to avoid the term 'grip' ('Get a firm and secure grip') as this implies a tight hold; this may not be appropriate, particularly for patient handling situations. It was thought that 'hand-hold' may be a better phrase.

- The term 'self-paced' may not be helpful – may need to specify that the speed should not be too fast.

- Delegates wanted the guidance to be less formal.

- Flowcharts may be useful.

- Possibly include more pictorial examples.

- Broader (i.e. include more situations).

- Applicable to all parts of all tasks.

In relation to the handling tasks, delegates wanted:

- Some hierarchy placed on the risk factors
- A hierarchy of principles. It was thought this could also be useful for risk assessment.
- Guidance on alternative ways of handling e.g. if you cannot avoid leaning you should ....
- Further guidance on team lifting e.g. appropriate weights and postures to adopt.
- More information on maximum recommended weights for loads in different postures.
- More information on the type of grip to adopt: is it better to use a power grip or flat palm grip?
- Guidance on whether it is better to carry something on the back (awkward postures may be required to get it on) than to carry something in one hand (e.g. laptop computer)?
- Different guidance may be needed for lifting and carrying (depending on the distance).
- Delegates would like some information on what constitutes 'light lifting', which may be what is recommended by a GP for those who have had back pain.

Other information requested relating to the context of handling:

- The guidance should place an emphasis on personal responsibility and consequences of handlers' actions.
- Would like more mention of the risk of injury if the load suddenly falls.
- Would like more labelling of weights of loads, although it was recognised that this is not possible for many loads (e.g. refuse sacks).
- Suggested that the guidance include a recommendation to 'warm up' the muscles before handling.
- Would like guidance on how often to undertake risk assessments and when to review the safe systems of work.
- Would like risk to be quantified more than into 'low', 'medium' and 'high' classifications.
- Would like some cost-benefit analysis on the benefit of training.
- Would like more information on the types of injury sustained when manual handling.
- Would like a web site that has all manual handling aids etc available, that was kept up to date so people could know products available.
- Would like further guidance on handles; it was thought that people tend to use the handle rather than holding the load close to the body. Also some debate about whether making a

load easier to hold will mean that a greater weight is carried placing a greater strain on the musculoskeletal system (depending on the nature of the handles).

Other comments relating to culture

In the discussions it was intended that difficulties which could be addressed through improved load, task or workplace design would not be the main focus; rather that attention was paid to handling situations where little could be done to alter the load, and awkward postures may therefore result. However, it became clear that in many situations, while steps could have been taken to re-design the load, task or environment, or lifting equipment could have been provided, there were reasons why this had not happened, e.g. poor communication, lack of management commitment or resources etc. Many of the situations outlined therefore forced awkward postures. One clear message from the groups was that there was a need for management commitment to these issues for any changes to be implemented effectively.

- Difficulties with overcoming cultural issues in handling – the handler may need help with handling, but this is often not asked for in some industries due to a macho culture. The guidance needs to stress importance of not lifting beyond your capacity.

- Concern that some people may be resistant to ‘new’ training techniques, or unwilling to change their behaviour.

- Also, the need for manufacturers to consider the delivery of their product – importance of communication at all levels.

- Important to make training relevant to people’s home environments, so they can apply what is taught outside of work. (MH problems are cumulative and work activities may only be a small part of the contributing factors).

- Discussion of the need to raise public awareness further concerning manual handling. Ideas were to get manual handling guidance into GPs’ surgeries, shops etc.

- Awareness of the cost of handling equipment / cost of re-design measures which may prevent them being implemented. In the short term it is less costly to not introduce these measures.

- There were many comments, and considerable frustration that the issue of manual handling was not taken seriously at a high level, particularly within the patient handling environment. External pressure is thought to be needed to alter this.

- Recognised the need to provide information on the costs and benefits of manual handling policies / equipment / training and of back injuries to persuade management to take this seriously.

- General feeling from delegates was that good manual handling principles are not currently being widely applied, even where people have been trained in them.

Appendix 3 Manual handling videos examined

Title	Supplier	Date
Manual handling for industry	Vocam Ltd	2000
Warehouse manual handling	Vocam Ltd	1996
Manual handling in the office	Vocam Ltd	2000
Watch your back	CFL vision – distributor Schwops – producer	1992 & 1999
Safe lifting and manual handling	Loss Prevention Council	1998
Catering for lifters	National Back Pain Association and Shell	1987
What the papers weigh (handling bundles of newspapers and magazines)	HSE	1999
Better backs for gardeners	NBPA	1993
That's manual handling to you.	Spot on productions, Asda vision	late '80's
Manual handling in the office	CCD. Produced by John Burder films	1993
Don't pick up an injury in catering	Workcare Ltd	?1999?
Don't pick up an injury in retail	Workcare Ltd	?not known
Don't pick up an injury in construction	Workcare Ltd	1994
Don't pick up an injury in offices	Workcare Ltd	?not known
Don't pick up an injury in warehouses	Workcare Ltd	?not known
Dealing with manual handling	Safetycare	1988
Lifting and carrying	Safetycare	1990
Ergonomics, the practical approach	Safetycare	1994

Appendix 4: Delegates at the Delphi exercise:

Achieving a consensus on the principles of good manual handling
25th September 2001

Dr Michael Adams	Bristol University
Dr Mark Boocock	Health and Safety Laboratory
Mr Neil Budworth	British Printing Industries Federation
Prof Kim Burton	University of Huddersfield
Ms Lesley Crozier	Manual handling trainer
Prof Don Grieve	Royal National Orthopaedic Hospital
Dr Roger Haslam	Loughborough University
Dr Christine Haslegrave	University of Nottingham
Dr Sue Hignett	Nottingham City Hospital
Mrs Nicola Hunter	Bury Physio
Dr Idsart Kingma	Free University of Amsterdam
Dr Mike Llewellyn	QinetiQ Ltd
Dr Lynn McAtamnie	COPE Occupational Health and Ergonomics Services Ltd
Dr Marianne Magnusson	University of Aberdeen
Mr Peter Malaczek	Representing RCN
Dr Corrine Parsons	RM Consulting Ltd
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Dr Ian Randle	Hu-Tech Associates
Mr John Ridd	JRP Ergonomics
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Alison Melrose	IOM
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Appendix 5: Delphi pack

Contents

Institute of Occupational Medicine

DOCUMENT 1

Delphi Exercise: Achieving a consensus on the principles of good manual handling

Principles of good handling, enshrined in L23

Below is a summary of the handling principles that are contained within L23. In the first section, the principles relating to handling and movements in paragraphs 120 – 172 are summarised. Many other principles relating to load, workplace, task, and environment design are contained in this guidance, but are not summarised here. The second section summarises the handling and movement principles as detailed in paragraph 174.

Paragraphs 120 - 172

- When handling at or near floor level, preferably use handling techniques which make use of the relatively strong leg muscles rather than those of the back, provided the load is small enough to be held close to the trunk. Bear in mind however that such techniques impose heavy forces on the knees and hip joints which must carry the weight of the load and the weight of the rest of the body.
- Place feet beneath or adjacent to the load
- Move close to the load before beginning the manual handling operation
- Hold the load (as) close to the body (as possible) during the manual handling operation
- Address the load squarely before beginning the manual handling operation.
- Preferably face the intended direction of movement before beginning the manual handling operation
- If possible, avoid lifting loads from the floor when seated
- If possible, avoid twisting, stooping or stretching when handling.
- Where a load is bulky rather than heavy it may be easier to carry it at the side of the body if it has suitable handholds, or if slings or other devices can be provided.

Principles for a symmetrical, two-handed lift (paragraph 174):

1. Stop and think (plan the lift)

2. Place the feet
   - Have the feet apart, giving a balanced and stable base for lifting
   - Have the leading leg as far forward as is comfortable

3. Adopt a good posture
   - Bend the knees so that the hands when grasping the load are as nearly level with the waist as possible; but do not kneel or overflex the knees.
   - Keep the back straight, maintaining its natural curves (tucking in the chin while gripping the load helps).
   - Lean forward a little over the load if necessary to get a good grip.
   - Keep the shoulders level and facing in the same direction as the hips.

4. Get a firm and secure grip
   - Try to keep the arms within the boundary formed by the legs.
   - The optimum grip may vary, but it should be secure.
   - If you vary the grip while lifting, do this as smoothly as possible.

5. Don't jerk
   - Carry out the lifting movement smoothly, raising the chin as the lift begins, keeping control of the load.

6. Move the feet
   - Don't twist the trunk when turning to the side.

7. Keep close to the load
   - Keep the load close to the trunk for as long as possible.
   - Keep the heaviest side of the load next to the trunk.
   - Slide the load towards you before attempting to lift it.

8. Put the load down, then adjust its position

Guidance on carrying (appendix 1)

- Similar (risk assessment filter) guidelines apply to carrying operations where the load is held against the body and is carried no further than about 10m without resting. If the load is carried a longer distance without resting, or the hands are below knuckle height then a more detailed risk assessment should be made.

- Where the load can be carried securely on the shoulder without first having to be lifted (as for example when unloading sacks from a lorry) the guideline figures can be applied to carrying distances in excess of 10m.

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DOCUMENT 4

Delphi Exercise: Achieving a consensus on the principles of good manual handling

SCIENTIFIC EVIDENCE RELATING TO LIFTING TECHNIQUE

Introduction

Manual handling training has been regarded by many as the mainstay of action in preventing manual handling injury for many years. Davis (1978) attributes this to some extent to the work of McClurg Anderson (1951) and others. However, Davis questioned the correctness of much of the training provided, particularly that espousing what he called the 'straight back, bent knees lift', characterised by a narrow symmetrical foot posture. Graveling *et al* (1985) raised further issues, questioning not only the scientific correctness of some lifting techniques advocated but also the utility of such training given the many practical situations where 'lifting with your legs, not your back' was not feasible.

For many years therefore, training has been provided that follows, to some extent at least, the basic tenets of maintaining a 'straight' back (i.e. retaining the natural lumbar lordosis) and bending the knees to lift. This apparently stems primarily from a perceived need to protect the spinal column from injury, with studies based on measurement or prediction of intervertebral disc pressure. However, medical evidence is that most episodes of back pain are 'mechanical' in origin; do not implicate the discs or related structures; and principally involve short-term injury to soft-tissue structures. It is perhaps appropriate therefore, as part of this review, not only to consider the evidence for one handling technique over another but, within that, to consider whether it is correct to give priority to techniques that protect the spine, possibly at the expense of placing soft tissues (muscles, ligaments, etc.), or other joints (eg. the knee) at more risk.

The purpose of these notes therefore is to identify and present an overview of the scientific evidence that would inform discussion of optimum handling techniques. It is intended both to examine the conventional wisdom of the two-handed symmetrical lift and to explore the evidence available to allow guidance to be formulated on other handling techniques such as single-handed lifting or lifting in spatially restricted workplaces. Factors such as frequency of handling must also be taken into account. Although some evaluative criteria include numerical guidelines based on physiological (fatigue) criteria, what are the implications (if any) for lifting technique. Bejjani *et al* (1984) for example, advocate taking knee joint reaction forces into account, suggesting that at some critical level the risk of knee injury may outweigh the risk to the back.

These notes have been derived from the scientific literature. They are not believed to reflect all the information that might inform debate and any further contributions would be welcomed.
No attempt has been made to place any particular interpretation on these notes as that might pre-empt the outcome of the consensus-forming exercise.

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Background Material

Adams and Hutton (1982).

Pure compression of an intervertebral joint invariably leads to vertebral failure even with fatigue loading.

Chaffin *et al* (1999)

Unfortunately, until more complex micromodels of the discs and facets are devised and experimentally validated, rules regarding the “best” or “safest” back posture to use in lifting must be regarded as speculative.

Under dynamic [lifting] conditions, muscle recruitment strategies result in complex timing of peak muscle forces.

de Looze *et al* (2000)

The abdominal muscles, in cooperation with the deep intersegmental back muscles, are involved in stabilising the spine. As a negative effect, the back and abdominal muscles largely determine the load on spinal motion segments.

The observed differences in L5/S1 torques and back muscle activation patterns between the known and unknown conditions indicate a higher low back load when the mass to be lifted is not known in advance of the lift attempt.

Nachemson, (1980)

Approximate load on L3 disc in 70kg individual – based on intradiscal pressure

Activity	Load (kg)
Standing	70
Twisting (unspecified amount)	90
Bending sideways	95
Bending forward 20°	120
Bending forward 20° with 10kg in each hand	185
Lifting 20kg, back straight, knees bent	210
Lifting 20kg, back bent, knees straight	340

White and Panjabi (1990)

Discs do not herniate under compressive load (p5)
Bending and torsional loads probably more dangerous to disc than axial compression (p74)
Central compressive loading leads to symmetrical bulging therefore herniation posterolaterally must be due to other factors (p6)

Shear stiffness of disc very high, i.e. rare for annulus to fail due to shear loading (p9)
Spinal segments tested with full flexion, plus lateral bending 26 of 61 samples had sudden disc prolapse with sudden compression.

Spinal segments tested with simultaneous flexion, some lateral bending and compression. Six of 49 samples had gradual prolapse; 35 had vertebral failure.

Squatting or bending (sagittal plane)

Adams and Hutton (1981)

With an unflexed lumbar spine (>2°), compression loads the facet joints, possibly causing damage; Moderate flexion (flattened lordosis, 4-8°) no damage should result; Increased flexion (6-18°). Average angle at prolapse 12.8° which is greater than normal physiological limit.

Suggests prolapse may be preceded by initial damage to supraspinous and interspinous ligaments; or rapid bending (leading to hyperflexion); or prolonged flexion can lead to 'creep' in the ligaments.

Straining at a single lift might damage back muscles or soft tissues.

Adams and Hutton (1982)

Flexion just beyond the physiologic limit results in damage to the ligaments of the neural arch but not the disc.

A prolapsed lumbar intervertebral disc can be a compression injury to a joint flexed a few degrees beyond the normal limit.

Adams and Hutton (1986)

When a person bends forward as far as they can, the osteoligamentous lumber spine is flexed about 10^o short of its elastic limit.

By stopping flexion 10^o short if the elastic limit, these structures considerably reduce the bending stresses on the lumbar spine. For a typical motion segment, a 2^o reduction in flexion means a 50% reduction in the resistance to bending moment and hence a 50% reduction in the bending stresses in the posterior annulus and intervertebral ligaments.

At the limit of the range of flexion, the osteoligamentous spine resists a bending moment equal to about 50% of that exerted by the upper body in forward bending. This means that at the more moderate angles of flexion found in life only about 25% of the upper body's forward bending moment will be resisted by the spine; the rest will come from the lumbo-dorsal fascia, back muscles etc.

One can bend forward to a greater extent in a rapid movement when gravitational forces are augmented by dynamic forces from the decelerating upper body. The margin of safety them might be reduced or eliminated entirely. Rapid movements are more risky in any case, as the muscles and ligaments are viscoelastic and resist fast deformations more strongly.

Anderson *et al* (1978)

Electromyographic activity greater in vertical pulling with a straight back than with flexed back (handle 20 or 40cm from floor) (nb horizontal distance changes).

Ayoub and Mital (1989)

Application of predictive equation gives 596 kg force lifting 20 kg outside knees (bent knees), 526 kg force bent back.

Chaffin *et al* (1999)

Reach forwards when upright, moment on lumbar spine is approximately 14.6 Nm, when leaning forwards, moment is 121 Nm (average male, no load in hands).

Shear forces larger when stooping (500N) compared with the squat posture (340N).

[What is the best lordotic curvature for the spine?] Some experts advocate pre-tensing the erector spinae before beginning a lift, thus increasing lordotic curvature. One reason for this manoeuvre is that it relieves any strain on the posterior ligaments which can occur when the back is rounded and the pelvis is rotated forward.

When the torso is near a fully flexed position, although the posterior exterior muscle's active tension is greatly diminished, the passive tension is quite high and combines with the posterior ligaments to provide a sizeable bending moment capability.

Marras (2000)

Significant load sharing occurs between the apophyseal joints and the disc. The proportion of the shared load can change dramatically as the spine changes positions.

Németh and Ekholm (1985)

The optimum hip flexion angle is 35°, other angles lead to an increase in femoral head loading (critical for osteoarthritis).

Park and Chaffin (1974)

Stoop lifting produces a lower disc compression than squat lift if load is too large to bring between knees.
Lifting with the back at an angle (leaning) results in shear forces counteracted by facet joints

Poulsen 1981

At full flexion, the back muscles are inactive, the load being supported by ligaments etc.

Troup *et al* (1983)

IAP in lifting, lowest with back lift
IDP in lifting, lowest with back lift

Low handles probably required stooping forwards

White and Panjabi (*op cit*)

Back flexion gives largest increase in ligament length for supraspinous and interspinous ligaments (p27).

Anterior longitudinal ligament not disrupted by flexion/extension but by rotation (p21). Sudden lifting more likely to lead to ligament failure (p23). Ligament failure is beyond the normal physiological range of movement therefore failure is unlikely in normal activity but extremes of motion should be avoided (p26).

Whitney (1958)

Vertical lift force (strength) varied by 100% with foot position relative to hands. (30cm heel to bar; >50cm heel to bar).

Lift strength not markedly influenced by use of 'derrick action' (bent back) or knee action. Earlier work cited as stating that knee lift minimises strain to the posterior ligament of the spine.

Lifting and twisting

Adams and Hutton (1982).

Torsion has been shown to damage the articular facets and, if carried well beyond the physiologic limits, to produce circumferential tears in the annulus fibrosis.

Ferguson *et al* (1992)

Task asymmetry (transverse motion) decreases trunk strength. Maximum decrease 10-11% at 180° rotation.

Kumar and Garand (1992)

Report reductions in trunk muscle peak strength with differing degrees of twisting. Difficult to identify consistent trends. Stooping and twisting generally worse than squatting and twisting when close to body. At half arms length, stoop + 30° twist, 15% reduction; stoop + 60° twist 30% reduction; squat + 30° or 60° twist, no effect. At arms length, stoop + 30° twist 5% reduction; stoop + 60° 25%. Squat + 30° twist 25% reduction; squat + 60° twist 20% reduction.

Jäger and Luttmann (1992)

Torsional disc strengths of up to 115 Nm reported. In the intact trunk, torsional loadings will be compensated for by muscle groups therefore the loading transmitted to the spinal column is difficult to interpret.

Kelsey et al (1984) report that twisting and specifically twisting without bending the knees increase risk of a prolapsed disc for certain lifting tasks.

A combination of forward flexion and lateral bending increases the probability of injury (Adams and Hutton, 1982a, 1983a).

A combination of flexion, rotation and compression produced annular separation and subsequent prolapse of the disk in the spine of cadavers (Gordon *et al*, 1991).

White and Panjabi (*op cit*)

Torsional resistance of disc varies. Little force is required to produce 0-3° deformation. From 3-12°, force and response (deformation) is linear. Failure occurs at 20° or more torsion. (nb this is spinal column twisting <u>not</u> trunk).

Lateral flexion

Kumar 1980

Peak IAP significantly higher in lateral lift (45° right) than in sagittal plane (straight back-bent knee lift).

Similar pattern for erector spinae emg activity. Less marked pattern for external oblique.

Lifts over greater distances (e.g. ground to shoulder) in sagittal plane evolved smaller IAP responses (and normally emg) than shorter travels (e.g. ground to knee) in asymmetric lifts.

[presumably because rotation is over shorter distance/timescale].

White and Panjabi (op cit)

Tensile strength of disc greatest in posterior and anterior regions. Lateral bending will stress opposite side. (p 6/7)

Asymmetric postures

Allread *et al* (1996)

One-handed lifts generated probabilities of low back disorders equal to or greater than corresponding two-handed lifts that were 45° more asymmetric. In other words, one handed lifting equates to 45° twisting.

Unsupported one handed lifting increases the risk of low back disorders by 7% compared with two handed lifting.

'High risk' back motions (maximum sagittal flexion, maximum lateral velocity and average twisting velocity) were significantly greater for one-handed lifts than two-handed lifts.

Kim and Chung (1995) report that asymmetrical posture has a big influence on the trunk muscular activity during lifting, and should be avoided. If an asymmetric posture is employed, it is recommended to place the external load on the opposite side to the worker's dominant hand so that workers can utilise muscles on the dominant side as the contralateral muscles which play a primary role in an asymmetric posture. It is not clear from the literature how the load was handled asymmetrically; the load was positioned at the subjects' right hand side to give an asymmetric 90°. Subjects bent down to lift the load, lifted it onto a surface (720mm), lowered it, and stood up again.

Leskinen and Waters (1997)

Asymmetric lifts are regarded as one of the major risk factors for work related lumbar spine disorders.

Marras *et al* (1995)

Three lumbar spine motion parameters were associated with the probability of being in a high risk of low back disorders group. These factors were maximum sagittal flexion, maximum lateral velocity and average twisting velocity.

Marras & David (1998)

During asymmetric lifts, the support of the external load is shifted from the large erector spinae muscles to smaller, less capable oblique muscles.

Increases in trunk muscle coactivity has also been associated with increased asymmetry and results in increased shear and compression loading on the spine.

One-hand lifting resulted in more sagittal flexion and lateral velocity but lower three-dimensional accelerations and twisting as compared to two-handed lifting.

The cross-sectional areas of the erector spinae, external oblique and internal oblique muscles on the right-hand side of the body were 10-14% smaller than the corresponding muscles on the left side muscles, whereas the rectus abdominus muscles on the right-hand side of the body were 11% larger than the left side.

Using the hand on the same side as the asymmetric lift reduces compressive force over using both hands or the opposite hand (by about 13%).

Using the hand on the same side as an asymmetric lift increases lateral shear force over using both hands or the opposite hand.

For a given asymmetry, lifting from the left of the sagittal plane resulted in greater mean peak spine compression than lifting from the right (handedness of the subjects was not reported).

One hand or two?

MHRU (1980)

IAP contours, one-handed lift limits usually more than half two-handed values i.e. dividing load in two may make it acceptable for single hand lift but combining two single-handed loads might exceed guidelines.

Hand position

Pinder *et al* (1999)

Investigated lifting weights, either using 2 bars, one at each side, or one bar positioned in front of the lifter. The maximum acceptable weight of lift, but no significant difference was found between whether the hands were positioned at the side or in front when lifting. However, this contrasts with the argument of McDaniel (1996) that lifting with the hands at the sides is safer than lifting where the object passes in front of the knees because the lifter can assume a more erect back posture and use leg rather than back strength, whereas the hands at the front lift forces the lifter to bend forwards and places more stress on the back. The load that was lifted in the Pinder study (a metal bar) could be brought relatively close to the body prior to lifting, and the authors acknowledge that there may have only been small differences in horizontal distance between the lower back and the hands meaning the maximum load moment was produced by the same load in both conditions.

Balance

Commissaris and Toussaint (1997) report that maintaining balance appears to be easier when lifting with a back lift (straight legs, bent back) than with a leg lift (bent legs, straight back). However, the study appears to have deliberately placed the load at some distance in front of the body and involved a feet-together lifting style.

Headroom

Ridd (1983)

Limited headroom causes a marked increase in intra-truncal pressure for a given handling task

Frequency or speed of lifting

Boocock (1998)

Up to a point, more frequent handling of smaller loads is preferable unless physiological (fatigue) limits are exceeded.

Vertical accelerative forces are greater with faster lifting rate.
Frequent lifting takes no account of cumulative biomechanical loading.

Chaffin *et al* (1999).

Inertial forces increase the compression forces on the LS/S1 disc considerably. [Calculated] peak dynamic moments at the L4/L5 disc were 19% higher than the static analysis predicted.

[Lifting slowly] peak dynamic force did not vary significantly from that predicted by the static model…….lifted at a more normal speed, peak dynamic force was 21% higher than static. Therefore lifted at a relatively fast speed, peak dynamic force was 43% higher than the static force.

Fast torso extension movements significantly increase amount of antagonistic muscle co-contraction, increasing predicted spinal compression forces by as much as 70% over simple static models.

Slower lifts are less stressful to the back, particularly when stoop lifting.

Jerk lifting can result in peak hand forces three to six times the weight of the object, particularly with light loads at high speeds.

Dempsey 1998

Spinal compression limits from cadaver studies take no account of cumulative loading of the spine. There is some evidence that this loading may be important.

Kim and Chung (1995)

Lifting at six per minute produced more rapid trunk emg fatigue although total weight handled was the same.

Lavender *et al* (1999) found that even during sagitally symmetrical lifting, lateral bending and twisting moments act on the spine, and these increase either with heavier weights or with faster lifts.

Marras *et al* (1995) showed that the risk of low back injury increases when more than 120 lifts per hour were performed.

Marras (2000)

The longitudinal ligament most frequently is subject to excessive tension resulting in avulsion or bony failure as the ligament can tear away from its attachment. Faster motions appear to increase the risk of these avulsions. However, the speed of motion necessary for such tears is much greater than these observed in the workplace unless a sudden slip or fall is responsible for the motion.

Park and Chaffin (1974)

Low back pain can result from muscle fatigue with repeated exertion.

Pinder (1997)

Below fatigue limit, physiological load vs frequency in not important.
Frequent lifting resulted in faster fatigue of the erector spinae with the same overall workload.

White and Panjabi (*op cit*)

The disc is viscoelastic, displaying stiffer behaviour with faster loading (p9).
Disc hysteresis decreases with repeat loading (i.e. the disc becomes less protective). In cyclical loading (forward bending 5° + compression) signs of failure were apparent after 200 cycles with failure after 1000 (p10).

Pushing or pulling

Chaffin *et al* (1999)

Cart pushing appears to result in significantly less compression force than cart pulling. Difference depends on torso angle which, in turn, depends on floor friction.

Pulling or pushing suspended masses (eg. hoists) results in similar compressive forces.

Twisting whilst pulling or pushing increases muscle antagonism; spinal compression; and spinal shear.

Load size

Mital and Kromodihardjo (1986)

The compressive and ground reaction forces increased with the load and box size.

Lifting loads in boxes with handles is safer and less stressful than lifting the same load in boxes without handles.

Lifting loads in smaller boxes was less stressful than lifting the same load in bigger boxes.

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DOCUMENT 5

Delphi Exercise: Achieving a consensus on the principles of good manual handling

Questions concerning the principles of handling: for discussion

This booklet contains the questions that have arisen from the difficult handling scenarios that were reported in the workshops. The aim of the discussion we will have on 25th September is to come to a consensus on the principles that can be advocated for good handling. It is hoped that we will be able to go some way to answering these questions.

The questions have been grouped into three sections. These are:

1. Principles concerning symmetrical two-handed handling
2. Principles concerning other forms of lifting
3. Principles concerning other forms of carrying

General questions and issues to discuss have been identified in each section. There is space for you to write your comments in response to the questions. Please do not feel limited to answer the questions; rather use them as the basis of written discussion. Note form is acceptable. Please feel free to add comments on the pages at the end, or use this as additional space.

It is accepted that there are many behavioural reasons why people may or may not adopt these handling principles. A balance needs to be struck between pragmatism and sound scientific advice. We would like to be able to provide principles that can be adopted in most handling situations.

We appreciate that there are many questions here which we may not have sufficient scientific information to answer. Please do not feel obliged to comment on each situation. We are very grateful for your input. Many thanks for your interest and support.

NAME:

1. Fundamental principles for symmetric, two-handed handling (lifting, lowering)

1.1 Documents 1 and 2 outline principles that are currently advocated for handling.

a) Please examine these principles and mark those which you consider essential (A) and those you would not advocate at all (or would positively advocate **not** doing) (X). Please list them below (or mark on Documents 1 and 2).

b) Is it possible to say which, if any, of these principles (category A) are more important than others? If you think it is possible, please indicate which you think is the most important principles (with number 1 being the most important).

c) If lifting from low down the handler needs to lose height. This can be done by flexing the knees, hips and back. The extent to which each of these is done will depend – in part – on the load. What are your views on the impact of these postures when handling?

d) Is it essential that the back is maintained in its natural curves during all handling?

e) Do these principles vary depending on what height is lifted from?

f) Do the same principles apply for lowering as for lifting?

1.2 Lifting a large load up and out of a container

If lifting a load (e.g. over the edge of the container) what is the biomechanical impact of raising the arms up compared with stooping down to lift? That is, is it better for the container to be placed on a surface (meaning starting the lift at about knuckle height, but then necessitating upwards arm movement) or on the floor (meaning starting the lift at below knuckle height).

1.3 Two handed holding of a load which has to be held away from the body (to avoid contamination)

Is it better to hold the upper arms in line with the body, with elbows braced against the body, and hold the forearms out, or to hold the whole arm away from the body? Can we recommend bracing the elbows against the body?

1.4 Two handed handling close to the ground (e.g. into a hole)

What guidance can be given on handling close to the ground?

Is it better to kneel or crouch, or lean forwards? Should a 2, 3 or more point base be recommended? Is it recommended to use one hand as a brace to support the body (meaning one handed handling) or to advocate two handed handling in these postures?

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1.5 Lifting / lowering when the handler is reluctant to bend their knees

Can we give guidance for those who have knee problems and are unwilling / unable to bend their knees?

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1.6 Two handed lifting

Is there a load below which the biomechanical benefit of using two hands to lift outweighs the biomechanical / physiological cost of moving both limbs to pick it up. This will obviously depend on the individual (and the load), but should we always advocate two handed lifting?

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1.7 Handles

Is there a difference between the position of hands / handles for lifting and the position of hands / handles for carrying?

1.8 Hand grip

Can we give advice on the benefits of different holds e.g. flat palm hold vs power grip?

1.9 Carrying more than one item

What guidance can we provide if more than one item is handled at one time?

2. Principles concerning other forms of lifting

2.1 Lifting a load with one handle (e.g. a bucket, bag)

a) Is it better to lift in front or at the side of the body?

b) Are there different principles depending on whether the handler is lifting from the floor, from about waist height, or higher?

c) Is it better if lifting between the legs to use one hand to brace the knees and the other to pick up, or to use two hands to pick up?

2.2 Lifting large, flat, vertical loads (e.g. doors, pictures, flat-pack furniture)

a) How should the handler lift these loads? Should they be lifted in front of the body or at the side?

b) Do these principles vary depending on the height the load is lifted from?

2.3 Lifting from a container where it is not possible to bend the knees

a) Is it best to approach the container from the corner, to allow the knees to be bent around the corner and the back to be kept reasonably 'straight'?

b) Should the handler support their upper body weight by handling with one hand and using their other arm to brace their upper body? Or is it better to use two hands to lift?

c) Should the handler brace their knees against the outside of the container?

2.4 Lifting into and out of the boot of a car

a) Is it best to brace the legs against the outside of the boot; or to put one foot inside the boot so the handler's body is closer to the load (does this cause greater lateral twisting of the spine?)

2.6 Handling in a confined space with limited headroom

a) Is it best to hold the load close to the body if the handler cannot stand fully upright or to stand over the load and hold it at arms' length (e.g. moving stacks of newspapers inside back of van)?

2.7 Handling when seated

a) Lifting loads from drawers when sitting down – is it better to lean to the side, or lean forwards if reaching down?

2.8 Handling when lying down (e.g. vehicle maintenance)

a) Only upper arm strength can be used – should weight limit guidance be provided?

2.9 Team lifting

a) If handling close together should handlers brace their bodies against each other? (E.g. use one arm on team mate's shoulder to brace yourself in an upright posture)

2.10 Balance when lifting light weights from low down

a) If lifting a light load from low down or from a horizontal distance from the handler should they counterbalance their body weight by standing on one leg, and raising the other behind them?

3. Principles concerning carrying

Many loads have to be carried once they have been lifted and before they are put down. These questions relate to the carrying of loads.

3.1 General

a) Are carrying principles different if carrying over short distances compared with long distances? e.g. placing the load on the back (e.g. backpack) may not be biomechanically efficient for short distance carrying.

3.2 Carrying a load with one handle (e.g. a bucket, bag)

a) If carrying a load with one handle, is it better to hold the handle in one hand and carry it at the side; hold the handle with two hands, and carry it in front; or not use the handle, and hold it with both hands against the body (acknowledge that lifting it into this carrying position may not be easy). This will partly depend on the nature of the load. However, assume that the load is stable and can be held against the body.

b) If carrying a load in one hand is it better to use the dominant or non-dominant hand? If the load has a handle and a strap (e.g. a laptop) is it better to use the handle, or the strap over the shoulder? If carrying on the shoulder, is it better to use the dominant or non-dominant shoulder? Should the strap be over the shoulder at the same side as the load, or on the opposite shoulder? Is it better not to use the handle at all and hold the load against the trunk?

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c) If carrying one handed and the load has to be held away from the body, is it better to hold the upper arm in line with the body, with the elbow braced against the body, and hold the forearm out, or to hold the whole arm away from the body? Can we recommend bracing against the body for one handed carrying?

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3.3 Carrying large (flat, vertical) loads (e.g. doors, pictures, flat-pack furniture and other large loads)

a) Should large loads be carried in front of the body (where they may interfere with walking, and have to be held up using upper limb muscles) or at the side of the body (with possible twisting) or carried on the back (with associated forward lean)?

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b) If carried at the side of the body should the handler have their hands holding the side of the load (and possibly twist their back); or with one hand at the base of the load, with the load partially supported on their shoulder (with possible neck lean)?

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c) Should the weight be supported on one hip (e.g. resting a box on the hip and supporting with one arm)

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3.4 Team carrying

If two people are handling a large load – is it better for both to walk sideways (which will involve some twist of the back for both lifters) or for one to walk forwards and one to walk backwards, or both to walk forwards (with the front person holding the load behind them)?

3.5 Carrying on different parts of the body

Can we recommend carrying on one part of the body over another?

i.e. consider the biomechanical impact of carrying:

a) on one shoulder

b) on the back

c) at one side

d) in front of the body

3.6 Carrying while negotiating obstacles

a) If the route were planned appropriately this would not be required, but if carrying over a long distance it will not be possible to prepare the route all the way; and in many observed situations, people do not plan their route appropriately. Would it be better to put the load down, then open the door (or remove the obstacle), then pick it up again, or to try to open it while handling by balancing it against the body and holding it with one hand?

b) What principles can we give for carrying up / down stairs or around corners

Any other comments

Please use this space for any other comments relating to handling principles.

Thank you again for your help

APPENDIX 6: Warming up : the scientific evidence

A6.1 Introduction

As part of the Delphi consultation (Section 6) there was some support for the advocacy of warming-up prior to lifting activity. However, other members of the panel questioned this, in particular whether there was any scientific basis to support the widely held 'belief' that warming-up was beneficial.

In order to investigate this issue and to determine whether the inclusion of advice to warm-up justified, an investigation was carried out of the published literature on this topic.

A6.2 Warming-up and manual handling

Searches specifically relating to manual handling identified a number of papers or articles advocating warming-up from as far afield as Mexico (Anon, 2001) and France (Anon, 1975). However, all appeared to be based on an assumption of benefit. For example, Taylor (1987) in an article on preventing low back injury stated that 'offering a before-work warming-up exercise program is another way to prevent low back injuries'. The author cites 'Japan' as being very successful in this regard but gives no specific source.

Some lay texts confuse fitness training with warming-up. For example, Luoke (1983) refers to developing strength and flexibility. The author cites a study by Cady et al (1999) in relation to benefits. Once again however this relates to the benefits of improved fitness, not specifically of warming-up.

Newman and Callaghan (1993) refer to the use of warming-up in their report of a survey of back problems and manual handling amongst nursing staff. However, the article addresses perceptions of the benefits of warming-up and willingness to use it amongst the staff. Curiously, the question related to warming-up alleviating the problem of back pain, rather ambiguous wording that could relate either to prevention or treatment. Almost 55% of responders stated that they did not feel that warming-up would be beneficial although only 42% would not participate in such exercises. Clearly there is some ambivalence in attitudes to the idea of such exercises.

Yassi et al (1995) present a paper on the epidemiology of back injuries amongst nurses at a major Canadian hospital. The authors draw attention to the higher rate of injury during the early hours of a shift in some 'high risk' wards. Because of this they tentatively suggest that a warm-up period might be desirable, implying that the injuries occur because the nurses are not prepared. However, elsewhere in the report they acknowledge that the high early injury rates on these wards are probably attributable to the fact that the greatest amount of lifting and transferring of patients occurs at the beginning of the shift for these staff. A predominance of injuries during the first hours did not occur in staff on other wards where this did not apply.

In summary, no papers have been found that present any scientific evidence for beneficial effects of warming-up in reducing musculoskeletal injuries from manual handling.

A6.3 Warming-up and sport

'Athletes and sportsmen and women warm-up, so it must be beneficial' is a widely encountered belief in discussing the topic with those concerned with manual handling. Franks (1983) summarised the situation stating that, of a number of studies on warming-up, conducted across three decades, about 55% had found warming-up (of some type) to be superior to rest; 5% found rest to be superior; and 40% found no significant difference.

More recently, Foss and Keteyian (1998), writing of the physiological basis for exercise and sport, referred to the conflicting evidence relating to warming-up, stating that some studies had shown that performance without prior warm-up is no different to that with warm-up whilst others have purported to show the benefits of warming-up prior to a heavy workout or competitive performance.

In papers relating to sporting endeavour it is necessary to differentiate between issues relating to warming-up for enhanced performance and warming-up to prevent injury. Foss and Keteyian (op cit) list three physiological reasons for warming-up exercises: (1) increased body and muscle temperatures; (2) increased blood flow and oxygen availability; and (3) decreases in contraction and muscle reflex times. Powers and Howley (1994) supplement this, differentiating between physiological; psychological; and safety benefits. Clearly, in a manual handling context the safety benefits are of primary concern. The authors state:

> 'most students of exercise physiology are familiar with
> the role of warm-up in the prevention of injuries'.

However, having stated this, they then proceed to cite the work of Franks (op cit) showing that little evidence exists to support this belief. Thus, although the work cited by Franks is at least twenty years old, there appears to have been little new evidence to emerge since.

Shellock and Prentice (1985) suggested that conflicting evidence in relation to the prevention of injury through warming-up stemmed from 'improper control groups, lack of cosistent methods, poorly designed protocols, etc'. Whilst the tenor of the article was supportive no details of the above claims were given to substantiate this. The authors specify a number of alleged physiological benefits including increased oxygen dissociation; lowering of activation energy rates of chemical reactions; increases in muscle blood flow; reduced muscle viscosity; etc. However, a relatively recent study (Magnusson et al, 2000) specifically studied muscle elasticity (extensibility) and found that increases in muscle temperature produced by warming-up had no effect on this.

This study also appears to contradict the views of Safran et al (1989) who stated that warm-up and stretching were essential to preventing muscle injuries by increasing the elasticity of muscles.

Warming joints through jogging prior to carrying out stretching exercises was studied by Williford et al (1986). Both jogging then stretching and stretching alone, improved joint flexibility although the relative merits of the two regimes were variable. The authors concluded that the results did not support the contention that warming the muscles prior to stretching was beneficial.

Further searches of the published literature on this issue showed that the picture remains unclear. The sports literature continues generally to promote the belief that warming-up is necessary whilst the associated scientific literature is somewhat equivocal.

Thus, High et al (1989) and Johansson et al (1999) reported that static stretching and/or warm-up did not prevent 'Delayed onset muscle soreness' whilst Rodenburg et al (1994) reported 'inconsistent' results. Rosenbaum and Hennig (1995) reported that stretching reduced the subsequent peak force; force rise rate and other characteristics of the achilles tendon reflex that were assumed to indicate improved muscle compliance and therefore reduced risk of injury. However, three minutes static stretching may result in fatigue of the stretch receptors, accounting for the changes documented.

Finally, the most recent review on this topic identified (Shrier, 1999) concluded that stretching before exercise did not reduce the risk of injury. Indeed, three studies cited apparently suggested that it was detrimental.

Support for this suggestion comes from work of Noonan et al (1994). These authors reported the results of passively stretching muscles/tendons (as might be done in warming-up). Stretching to 30% of failure force results in functional injury (reduced contractile ability) and histological evidence of tissue damage. Although these force levels were not related to the forces that might be created in warming-up, the study does present the possibility that over-zealous stretching as part of warm-up could cause injury.

A6.4 Discussion and Conclusions

It is evident from the literature that there is no clear evidence in relation to the perceived benefits of warming-up in preventing musculoskeletal injury. Indeed, there would seem to be some evidence that stretching alone could be harmful. It could be, as has been suggested by some authors that, if the challenge is sufficiently severe it will outweigh any modest benefit from warming-up. It should also be remembered that many of the studies are on athletes and others who have a generally higher level of activity in any case. What is clear is that, if there is any benefit it is highly specific to the form of activity and the nature of any injury. Thus stretching will be of little benefit in preventing an injury due to muscle overload or prolonged, repetitive use. Clearly however there is insufficient evidence to warrant the inclusion of warming-up advice.

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