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MASCIP
Multidisciplinary Association of Spinal Cord Injury Professionals

THE PATIENT IS FOR TURNING

THE ROLE AND USE OF MECHANICAL TURNING BEDS FOR PATIENTS WITH SPINAL CORD INJURY, ASSOCIATED MAJOR TRAUMA and COMPLEX CARE SCENARIOS

A report by a MASCIP working party in collaboration with the SIA Academy and funded by an educational grant provided by Nexus DMS Ltd

MASCIP - The Multidisciplinary Association of Spinal Cord Injury Professionals (www.mascip.co.uk)
SIA - The Spinal Injuries Association (www.spinal.co.uk)

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INTRODUCTION

This report is primarily intended as a guide to the management of patients with actual, potential or uncleared spinal cord injuries (SCI), but it also encompasses a range of other complex conditions and care scenarios which can often accompany SCI.

The information provided within is intended to illustrate both the general and specific benefits of the routine turning and repositioning of patients with SCI and similar complex care needs whether by manual or mechanically assisted means. This work is intended to supplement the original MASCIP Moving and Handling Guidelines which were published in 2009 (www.mascip.co.uk/guidelines.aspx) by updating the core principles underpinning patient and carer safety, reviewing the holistic benefits of regular turning and developing further the role and use of mechanical turning beds within acute and critical care environments.

The management of this project was coordinated between the Multidisciplinary Association of SCI Professionals (MASCIP) and the Spinal Injuries Association (SIA) with the support of an Educational Grant from Nexus DMS Ltd. The multidisciplinary clinicians within the project team that developed this resource (page 38) were chosen to represent the skills and experiences of healthcare professionals employed within a wide range of clinical specialities: Spinal Cord Injuries, Spinal Surgery, Trauma Orthopaedics, Critical Care, Neurosurgery, Neuromedicine and Acute & Elderly Medicine. The project group also set out to deliberately challenge the acquisition of confidence in the use of a mechanical turning bed to support the moving and handling of complex care patients by including agency nurses and student nurses within its membership.

At the time of project launch, Nexus DMS Ltd was one of a number of companies providing or developing mechanical turning beds for NHS purchase. However, for commercial reasons of their own, the other companies had withdrawn their products from the market prior to the launch of Nexus DMS Ltd's *Legacy* complex care turning bed - eliminating the possibility for meaningful comparison between similar contemporary products.

All pictures included are intended for illustration only and, while the narrative herein necessarily refers to specific features of the *Legacy* product as used in the demonstrations shown (to outline the specific methods and benefits depicted), this publication does not constitute any form of user instruction manual, marketing tool or product endorsement by any of the participating health professionals, MASCIP, National Back Exchange (NBE) or SIA Academy.

All techniques were performed under the supervision of a qualified Moving and Handling Trainer & NBE member. The postures of participants in all photographs were REBA (Rapid Entire Body Assessment) scored (see Appendix) for suitability before publication.

The bed used in the illustrations represents a developmental stage model. As a result of this project, significant changes have been made to the Nexus *Legacy* bed design and the current production model incorporates a wide range of improvements and additional features suggested by the MASCIP-SIA Project team.

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SHOWCASING THE UNIQUE FEATURES OF THE LEGACY COMPLEX CARE TURNING BED

It is at this stage of the report that we are required to justify the inclusion of some of the pages because they may be open to some misinterpretation. On completion of this report it was submitted to the MASCIP Committee for approval and comments. As a result, it was decided that further assurance should be provided that this report is not intended as an instruction guide for commercial promotion or use. Please note that Nexus DMS Ltd provides a separate user guide to the operation of the *Legacy* bed, as well as their own introductory and training video, available online at: **(http://www.nexusdms.co.uk/professional-care-products/product-legacy-bed).**

Whilst mechanical turning beds have been in use within the NHS for more than 50 years, their routine use outside of specialist care environments has never been realised in the way that Sir Ludwig Guttmann hoped. Far greater success has been achieved in the adoption of mechanical hoists and even sliding sheets as a means of reducing the physical strain upon carers during moving and handling operations. In the management of most complex care patients, routine turning remains a manual handling procedure.

One of the aims of this project was to illustrate how mechanical turning beds can remove or relieve the strain of generic manual turning in a way that has never previously been attempted. This showcase is about options for avoiding manual turning across the NHS as much as within complex care scenarios.

MASCIP, in common with the NHS, invites and supports design innovations and hopes that this report will encourage other developments in bed design and manufacture. Our project aims require us to showcase within this report the collaboration between NHS clinicians and engineers which led to the radical redesign and re-engineering of an essential piece of equipment in the management of SCI patients. When the original development team from Oswestry SCI Centre first sat down with Nexus DMS Ltd it was over a blank piece of paper. The design of what was to become the *Legacy* bed has been developed and refined over several years and the evolution from the original design carcass has been refined with continuing reference to a diverse range of professionals associated with the project team.

The command and control features are unique in their design and placement. The project team placed upon itself the responsibility for testing this concept. Our approach was modelled on that taken in professional journals where a commercial product is tested and critically appraised against its use within simulated practice scenarios before clinical trials. Normally, there would be the potential to critique against other products in use but, as explained previously, no other companies intend to continue in production. The only other specialist bed we could find in this situation is the KCI *Clinitron* air fluidised bed. However, throughout this report we have compared the mechanical turning of patients against traditional manual methods.

The team found several shortcomings in the original design which had not previously been recognised. As a result of this project, the bed manufacturer was able to improve upon the original design and location of the command and control switches, emergency stop and power on/off buttons.

On pages 16-17 we explain and critique the standard mechanical turning technique, making due reference to the operation of the side wings which is a feature unique to this bed and required appropriate testing and reassurance. The pressure relieving side-flap is also unique and previously unseen and we had to assure for ourselves that patient alignment would be maintained.

The 2009 MASCIP Guidelines demonstrated how the *Atlas* mechanical turning bed could be used to undertake a mechanically assisted log roll and on pages 18-19 we confirm that this facility continues in the *Legacy* bed and has even been improved upon. However, the command and control operations appeared complex and so were robustly tested and refined where necessary by the manufacturer. Because they were the result of trialling and discussion they are presented on pages 13-14 in representation of the amount of effort the project team put into ensuring this technique could be undertaken without harming the patient or any member of the turning team.

On page 19 we introduce the embrace-hold position. This was originated by, and was an original thought engendered by the MASCIP project team.

On pages 24-25 the report illustrates some of the many generic concerns which should be highlighted to every bed manufacturer. Every bed should have an integral weighing facility and every ward struggles to safely and securely store loose bed attachments.

The double mattress system requires discussion on pages 26-27 because nothing like this has ever been provided within previous models of turning bed. Those who have used previous turning beds will be familiar with just how much debate there has been over the years regarding the adequacy or insufficiency of the various models of mattress provided. All of this was presented to the original design and development team, who then came up with the double mattress concept. The final mattress composition was not chosen by the manufacturer but was one of three designs piloted over 3 months by the National Spinal Injuries Centre at Stoke Mandeville Hospital.

Cervical traction (pages 28-29) was fast becoming a lost art but under current concepts for spinal trauma, providing for the conservative management of cervical spinal injuries remains an NHS requirement and previous versions of mechanical turning bed all provided for this facility. Provision for lower limb traction is a similar requirement of complex trauma teams.

The involvement of an SIA Peer Support Officer (PSO) as a volunteer patient reproduced the support provided for the 2009 MASCIP Guidelines. During the photo shoot it was the PSO's suggestion that a picture be taken to illustrate how bed height and positioning can positively influence communication for wheelchair-users visiting people in hospital (page 30). The same positioning is advantageous for many other staff required to sit down with patients during periods of supine lying.

The compatibility of the *Legacy* bed with other equipment on page 31 again reproduces the techniques shown in the MASCIP 2009 Guidelines. The ability to tilt the bed to assist lateral transfers is a design feature that has long been desired by users of the previous forms of turning bed but never achieved in the design until now.

On page 34 we make clear that whilst the NHS places a requirement upon bed manufacturers to provide a CPR release mechanism, no proviso is made for instructing staff in the inherent hazards or restricted use of this facility within complex care scenarios. This was a valuable learning opportunity.

Every effort has been made in the production and editing of this booklet to maintain a purely clinical and professional focus but the lack of a diverse product range has placed unreasonable demands on the project team to achieve this to the satisfaction of every reader. We hope that you can appreciate this report in the spirit intended. MASCIP will keep the report under review and continue to welcome any constructive feedback.

THE PATIENT IS FOR TURNING:

THE ROLE AND USE OF MECHANICAL TURNING BEDS FOR PATIENTS WITH SPINAL CORD INJURY AND ASSOCIATED COMPLEX INJURIES

CARING FOR THE MOST VULNERABLE PATIENTS

Spinal cord injured patients represent one of the most vulnerable groups of patients. The optimum holistic care of an acute spinal cord injured patient involves not only an understanding of the biomechanics of spinal stability and spinal alignment but also of the multifaceted physiological and related problems of the spinal cord injured person. Competency in their management involves not only the requisite technical skills but also a full understanding of the pathophysiology of the spinal cord injured person and the functional consequences of any treatment (NSCISB 2010).

PATHWAY FOR PEOPLE WITH SPINAL CORD INJURIES (SCI)

"It is the view of the National Spinal Cord Injury Strategy Board (NSCISB) that all newly injured SCI patients should be referred and transferred to a specialised SCI Centre at the earliest opportunity after their injury. It applies equally to trauma patients, and to those whose injury is of non-traumatic origin. Spinal cord injured patients may require admission to other acute hospitals because of co-existing injuries, the need for complex spinal or other surgery, the need for other complex therapy such as endovascular treatment or renal dialysis, or simply because there is no SCI bed available. Every hospital receiving trauma should have a defined link with a specified partner SCI Centre, allowing the joint development of written protocols for management of the general complications of spinal cord injury to be agreed. 24 hour image transfer will be required to allow appropriate decision making. Where immediate transfer to the SCI Centre is not possible because of a head or other severe injury, the newly injured patient should still be referred to the SCI Centre immediately, so that the SCI Centre can advise on the appropriate management of the patient, and provide acute outreach services. Similarly, if the SCI Centre has no bed immediately available, they should provide telephone advice on the management of the patient, and provide acute outreach services". (NSCISB 2010).

The management of Spinal Cord Injuries in England is a Specialised Service within the NHS Commissioning Framework (SSCT 2012) designed around a network of 8 Spinal Cord Injury Centres. Through the work of the NSCISB, NHS England has evolved seven individual care pathways which encompass the lifetime care needs of SCI people from first diagnosis through to end-of-life care (www.mascip/sci-roadmap.aspx), Guidelines for the acute care and management of SCI patients can be found in the Reintegration Care Pathways.

ORIGINS OF THE PROJECT

In 2009, a working party of the Multidisciplinary Association of Spinal Cord Injury Professionals (MASCIP), in collaboration with the Spinal Injuries Association (SIA) Academy, produced a set of clinical guidelines for Moving and Handling Trainers (www.mascip.co.uk/guidelines.aspx). These guidelines established a common clinical consensus regarding techniques and equipment appropriate for handling and transferring actual or suspected SCI patients across a range of clinical scenarios. As part of these guidelines, the working party illustrated the use of turning beds for the management of SCI patients, particularly those with complex multiple injuries.

At the time of publication there were a number of companies producing mechanical turning beds for use within the NHS but soon after publication of the 2009 MASCIP guidelines the two main providers of mechanical turning beds to the NHS ceased production and those beds still in use will soon become unserviceable. This came as a shock to those NHS acute care providers with an established utilisation of mechanical turning beds within their patient care pathways. The need for, and use of, mechanical turning beds within the NHS has evolved over many decades for the benefit of both patient and staff wellbeing. In addition, much of the design and development of this equipment had occurred in partnership with NHS healthcare providers.

PROVIDING FOR A NICHE MARKET IN HEALTHCARE

MASCIP was concerned over this development because the NHS was about to embark upon a definitive national care pathway for SCI patients and the need for the appropriate provision of specialist equipment such as mechanical turning beds was a core concept within this plan. In addition, the potential need to provide for mechanical patient turning was also identified as a resourcing need within the establishment of Major Trauma Centres as all traumatic SCI patients would initially be admitted to a local Major Trauma Centre pending fitness to transfer to their local SCI Centre (NHS Clinical Advisory Group on Trauma 2010).

The MASCIP Committee was made aware that a new design concept for a mechanical spinal turning bed was being developed by Nexus DMS Ltd with the support of multidisciplinary teams from the SCI Centres at Oswestry, Stoke Mandeville and Sheffield and recognised that there was an opportunity for MASCIP to influence the future design and development of this new bed so that it could be utilised for complex care patients. MASCIP believed that this would be the best approach to secure the future availability of mechanical turning beds for SCI patients. The MASCIP project team was established in February 2011 to critically review the design concepts and establish parameters for use and testing during a 2-day residential workshop in June 2011 and a series of equipment evaluation trials within a variety of NHS hospital departments during 2012. The project team is also grateful for the support and advice provided by the National Back Exchange (NBE) and Designing for Dignity (D4D).

CORE OBJECTIVES

The core objectives established by the MASCIP project team were:

1) To review the evidence base which supports the current use of mechanical turning beds.
2) To establish the continuing level of need for mechanical turning beds within the current management of SCI patients and associated complex conditions.
3) To explore how traditional turning bed design parameters and care practices could be revised in accordance with the patient and user experience as well as innovations in clinical engineering, material design and product development.
4) To ensure that the contribution of mechanical turning beds in the management of SCI patients within NHS hospitals was assured for the future.
5) To consider the need for bed manufacturers to provide turning beds appropriate for multiple complex conditions rather than just the niche spinal/SCI patient markets and whether this should be established as a parameter for the NHS Purchasing Agency.

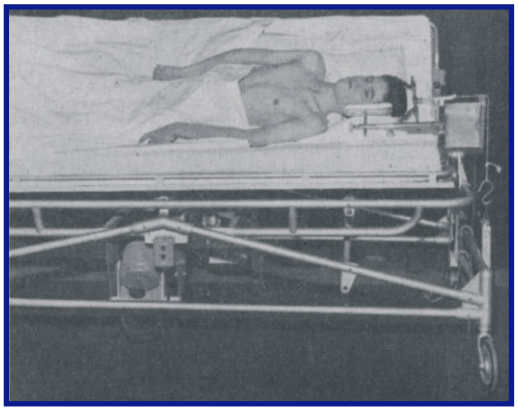
EQUIPPED TO CARE: BUILDING ON GUTTMANN'S LEGACY

Prior to the development by Sir Ludwig Guttmann of a comprehensive care pathway for SCI patients, the conservative immobilisation of the traumatic SCI patient in plaster casts and plaster beds until their spinal fractures healed was a commonplace strategy. This resulted in the horrendous complications of immobilisation and a subsequently high mortality and morbidity rate before the patient was transferred to a SCI Centre. Guttmann replaced this practice by placing the patients on foam mattresses with regular turning every 2 hours day and night, by nursing teams. In order to deal with the problem of the continuously increasing workload and the lack of staff, Guttmann in cooperation with Egerton Engineering Limited set out to modify the 'Stryker turning frame' that was then in general use for SCI patients. In 1967, Sir Ludwig Guttmann introduced his first turning bed designed for SCI patients in this manner:

"The care and management of any seriously ill patient after injury or disease places heavy demands on both nursing and medical staff if complications from recumbency, such as pressure sores, lung complications, and stasis in the urinary tract leading to ascending infection and stone formation, are to be avoided. People paralysed as a result of fractures or fracture dislocations of the spine have always been particularly prone to these complications on account of their bladder paralysis and the

initial loss of vasomotor control and tone of all tissues in the paralysed area, resulting in the lowering of tissue resistance to pressure. It is true that these complications can be avoided by the employment of pillows or sorbo-rubber packs, combined with regular two-hourly turning day and night, from the supine to the lateral position. However, four persons are necessary, especially in the early stages after paraplegia or tetraplegia, to carry this out properly, and the strain on the nursing staff is only too obvious. Because of the high survival rate of traumatic paraplegics and tetraplegics, even those associated with severe injuries to the chest and other parts of the body, on the one hand, and the increasing difficulty in obtaining adequate nursing staff on the other, turning beds have been introduced". (Guttman 1967).

Guttmann's concept was that his new turning bed was an evolutionary development in the management of all patients made vulnerable to preventable complications by their complex injuries. He perceived it as a practical and necessary step forward from the purely physical methods of turning and a technological advance from the design limitations of the previous.
Mechanical turning beds appropriate for the management of patients with complex care needs are not therefore an innovation, nor should they be perceived as exclusive to the care of traumatic spinal or spinal cord injured patients. Mechanical turning beds and therapeutic turning tables have become an increasingly familiar sight within critical and specialist care environments.
The *Stoke-Egerton* bed (picture 1 below) was the first definitive turning bed (as opposed to a turning frame). This evolved into the *Paragon 9000* and then the Huntleigh *Atlas* (picture 2 below). In parallel with this was the evolution and development of the *RotoRest* bed (picture 3 below), essentially a flat turning table designed and utilised mainly to provide kinetic turning therapy for respiratory management within critical care scenarios (Keane 1967). The Nexus *Legacy* bed (picture 4 below) has evolved from these predecessors in the way that Guttmann hoped when he launched his first successful design.



Picture 1: *Stoke Egerton* bed

Picture 2: Huntleigh *Atlas* bed

Picture 3: KCI *RotoRest* bed

Picture 4: Nexus *Legacy* bed

The 'bed' distinction was important to Guttmann because it also considered the need to provide a definitive mattress that would provide more appropriate pressure relief and improve patient tolerance. The folding mattress would also support the patient against the shearing forces experienced when turning on a therapeutic turning 'table'.

WHY TURN? REVIEWING THE HOLISTIC BENEFITS OF ROUTINE TURNING AND REPOSITIONING FOR COMPLEX CARE AND SPINAL CORD INJURY PATIENTS.

Concomitant injury in the presence of traumatic SCI usually necessitates a significant delay in transfer to the specialist SCI Centre until the patient's condition has been stabilised and the receiving centre can provide the appropriate level of care required. Such delays in transfer are associated with an increase in the potential for complications such as pressure ulcers and respiratory infections (Barr 2009). Pressure ulcers occurring at this time often result in an extended period of hospitalisation, protracted rehabilitation programmes, delayed discharge and, potentially, a reduced quality of life post-discharge, including early readmission to hospital (Barr 2009).

Frequency

The benefit of regular turning in the prevention of pressure ulcers is well established in clinical literature, particularly with regard to elderly frail and clinically dependent patients (Norton, *et al* 1975). Several points of concensus have evolved in this time. The standard frequency of turning has been established at 2-hourly for those at greatest risk (Reddy, *et al* 2006) although nursing judgement of the perceived individualised patient risk of pressure ulcers means that 3-4 hourly turning regimes can be just as efficient. In many instances, nurses amend turning schedules in accordance with patient recovery and rehabilitation goals.

However, there is evidence that many patients, particularly those within complex and critical care scenarios do not always receive the frequency of turns that their condition and potential recovery warrants (Krishnagopalan, *et al* 2004). These are predominantly due to the lack of nursing staff, on demand, to undertake frequent and often complex manual turns within critical care environments and a principal rationale underlying the investment by critical care services into the development of mechanical turning beds.

Pressure redistribution

The angle of lateral turn, when the patient is positioned at rest, should not exceed 30^0 (Seiler & Stahelm 1986; Young 2004). Positioned at this angle, the patient's body will hold position without shearing. Upper body weight is distributed along the torso and the able patient is not denied the active use of their upper limb for tasks such as eating or drinking. The weight over the lower body is also borne over a wider surface area, avoiding direct weight loading over the trochanter of the hip. Increasing this angle increases the incidence of skin shearing. When a greater angle (such as 90^0) is used for active chest physiotherapy then the dependent patient must be manually supported in this turn for the minimum period of treatment.

Prevention of complications

Hawkins, *et al* (1999) established that routine 2-hourly turning and repositioning of SCI and complex care patients during periods of acute bedrest can also reduce the incidence of multi-system complications by reducing the extent and duration of unrelieved pressure experienced by weight-bearing areas and the duration of fluid stasis within the organs and systems of the body. Harrison (2000 & 2007) summarised the potential for routine 2-hourly turning to reduce the incidence of pneumonia, pressure ulcers, constipation, urinary sepsis, thromboembolism, gastric ulceration and psychological stress in SCI patients nursed within Critical Care environments, including the use of both manual and mechanical turning. As the patient's physiological and systemic condition improves, a 3-4-hourly turning regime can then be introduced until transfer to a SCI Centre or specialist rehabilitation unit.

Respiratory care

Postural adjustment to improve the movement of secretions and mobilise fluids within the body whether by manual or mechanical turning makes empirical sense in the consensus opinion of most published works on the topic but there is a lack of definitive research on this matter. There is a definitive lack of consistency (in both subject and control groups) within evaluations regarding method of turning, frequency of turning, angle of turn and duration of turn. Ahrens, *et al* (2004) even ventured that: *"… lung models and the geometry of the tracheobronchial system suggest that simple turning will not effectively drain all lung segments because of the various geometric angles in the airways".* Despite this lack of a credible research base, rotation therapy for ventilated patients and those with acute respiratory conditions is fully embedded within Critical Care (Goldhill, *et al* 2007).

WHY NOT TURN?

On occasion, there is a patient whose spinal injury or general systematic health is medically assessed as being so unstable that routine turning would actually be detrimental to their current or continuing well-being. In such cases an entry should always be made on behalf of the multi-professional team which includes a consideration of mechanical turning. Other than this, the only patients 'not for turning' are those who can physically turn themselves without physical assistance or verbal prompting. In complex care, whenever the phrases *'can't turn', 'won't turn' or 'doesn't need to turn'* appear, in care records, it requires healthcare professionals to provide a credible justification for these decisions. Hawkins, *et al* (1999) determined that nursing and medical staff had developed a blinkered appreciation of the potential complications of prolonged immobility. Pressure ulcers are still perceived as the principal complication and the prime reason for turning patients. In addition, Hawkins, *et al* (1999) outlined how fears over the physical consequences to staff of routine manual turning of patients, and subsequent compensation claims for occupational injury had led to an over-reliance upon dynamic air mattresses.

The routine turning of complex care patients should be perceived as an essential holistic therapeutic action and therefore constitutes part of a patients treatment. Dynamic air mattresses were intended to reduce the frequency of patient turns and reduce the strain upon nurses' backs. Unfortunately, it is the belief of the project team that within many complex and general care environments inappropriate risk management and a misplaced faith in pressure relieving mattresses means this good intention has mutated into the situation that once a patient is placed on a dynamic mattress they become a patient who is 'not for frequent turning'. The MASCIP project team did establish with the major manufacturers of dynamic air mattresses that none of them endorse their products with sufficient stability to maintain spinal protection alignment for traumatic spinal/spinal cord injured patients during their initial acute management.

Within complex care facilities, if the perceived holistic benefits of regular patient turning can be realised, then the time a patient spends within one of the most expensive NHS environments may be reduced significantly, as may their time spent in hospital overall. If proven, the money saved could then be reinvested within the same initiative. However, finding evidence to prove this claim by using published studies is difficult.

HOW TO TURN - HEALTH AND SAFETY LEGISLATION

In 1992, the NHS adopted new manual handling guidelines based upon a European Directive (HSE 2004). The European Directive expected employers to risk assess their manual handling activities with the expectation that they should work to avoid or reduce the need for manual handling operations through a greater investment in mechanisation. The impact of this new legislation can be seen throughout the NHS with the ever-increasing employment of electric profiling beds, hoists, turning and transfer aids within acute hospitals. However, the potential to wholly turn the acutely injured and dependent complex care patient using mechanical means is yet to be fully realised to the same extent.

Elderly and acute medicine and neurorehabilitation employ a wide range of mechanical and pneumatic turning mattresses but none of these has proven sufficiently suitable for the routine turning of complex trauma patients. The MASCIP project team considers that the perceived expense and limited employment of mechanical turning beds beyond spinal/spinal cord injuries are the key contributors to this lack of investment in these products. At this point, the MASCIP project team decided that any future promotion of mechanical turning beds should emphasise their 'turning within complex care' potential over and above their current employment as 'spinal' turning beds.

ADDRESSING THE CHALLENGE OF STAFFING FOR COMPLEX MOVING AND HANDLING NEEDS

"Wherever there is a reasonable suspicion of acute SCI, the aim is to maintain full spinal alignment during any moving and handling activity. Careful handling, positioning and turning, on every occasion, can reduce the potential for secondary spinal cord trauma during patient transfers and movements. Maintaining full spinal protection during log rolling involves at least four members of staff to maintain spinal alignment throughout the procedure. Additional staff will be required to undertake examination or care associated with the log roll such as washing and checking of skin, placement of pillows, insertion or removal of transfer devices etc."(Harrison & Ash 2011)

There is no intention within this project to suggest that a mechanical turning bed could, or should, reduce the numbers of nurses required for a ward. However, when patients with complex handling needs are admitted acutely to hospital, without warning, it is normal for ward and departmental managers to face the dilemma of balancing the physical and holistic care needs of the patient not just against the protection of their staff from postural or repetitive strain injuries but also against the needs of their other patients and their clinical needs and priorities. Unfortunately, in complex care scenarios, not turning the patient with sufficient frequency is rarely an option. Managers are therefore forced to borrow staff from other wards or engage bank/agency staff for the duration of this patient care need scenario.

"Nurses required to undertake the turning or transferring of actual or potential SCI patients during the acute period must have supreme confidence in their ability to work as a team, especially when other health service staff are involved. It is essential that all moving and handling is coordinated by a nominated team leader." (Harrison & Ash 2011)

Members of established ward teams train together to an agreed standard of competence and frequently work together with an established confidence and rapport. Whenever casual nursing staff (or other healthcare workers) are introduced there is a potential dilution of the skill-mix and team cohesion (HSE 2004). The use of 'scratch' handling teams potentially increases the risk that manual handling incidents caused by poor coordination or communication may increase (HSE 2004). The exception is where the bank/agency staff or therapists are drawn from the local staff pool or where the hospital operates fully integrated 'scratch team handling' scenarios within its mandatory training schedule. In the evaluation to date, the *Legacy* bed offers ward and departmental managers the opportunity to manage complex injuries more effectively, reduce their usage of bank/agency staff, improve 'scratch' team working and reduce postural and repetitive strain.

The project team suggests that where spinal alignment is not essential but the patient is totally dependent upon nursing staff to turn them the *Legacy* bed could reduce the number of staff needed to perform a turn. A key implication in this scenario is that the patient has been risk assessed regarding their frequency and need for a regular skin check within their turning programme.

In those cases where spinal alignment is essential, particularly where there is a need to perform regular skin checks, then the maximum number of staff will be required to undertake a log roll turn but the *Legacy* bed can reduce the physical strain for the turning team members.

ACCESS ALL AREAS?

During the practical evaluation of the bed in clinical practice, the MASCIP project team ensured that each operator's posture was evaluated using the Rapid Entire Body Assessment (REBA) scoring tool (see Appendix). The assessments were carried out by an experienced Moving and Handling Co-ordinator with Post Graduate qualifications in Back Care and significant experience of using the REBA scoring tool.

Postural analysis was not just applied to the actual physical handling of patients, a turning bed has to enable staff to provide all care throughout a 24-hour period, including undertaking clinical examinations, bedside observations, the provision of hygiene, continence and wound care and feeding. The MASCIP project group ensured that in a range of representative clinical environments, circulation space around the bed was similar to or better than previous models in use. Bed manufacturers should ensure that their product is designed around a clear appreciation of the actual size of the available clinical environment. In particular, this should consider the size of the bed spaces and the footprint or access needs of a range of essential bedside equipment from lockers, through monitors and ventilators, to portable x-ray machines.

During clinical trials, the MASCIP project team paid particular attention to how easily the bed could be manoeuvred between departments, including movement into and out of lifts, between floors, negotiating gradients in corridors and accessing side rooms. A range of mechanical bed movers was also evaluated against the weight and dimensions of the bed to measure its compatibility against what is an essential strategy for mechanising bed movements in many NHS Trusts.

The exercise led the MASCIP project group to suggest that hospital managers should consider providing extra circulation space when designing or redeveloping complex care environments which have an established record of use or ownership of mechanical turning beds. This is particularly important in the case when designing a turning bed for bariatric patients.

A bariatric version of the *Legacy* turning bed is being designed by Nexus DMS Ltd as a future development. Considering their shared experiences of current bariatric care beds, the MASCIP project team advise that a bariatric turning bed should be designed not just to accommodate the weight of the patient but also their size. A bariatric turning bed will therefore need to be substantially wider, as well as stronger than a standard model, otherwise the unique turning feature will be lost or patient comfort and safety compromised if the mattress wings fail to sufficiently support the size, body shape and weight distribution of the bariatric patient.

Pictures above illustrate how posture during the positioning or exercising of limbs is just as important as during turning of the patient. Also when seeking venous access etc.

SUITABLE FOR EVERY BODY?

A turning bed must be able to conform to different body shapes and weights without compromising the position or alignment of the patient. The MASCIP project team utilised the full range of available body shapes and sizes available and found that the bed accommodated all of our volunteers in comfort and security throughout the full range of positions and manoeuvres. The bed employs integral telescopic side rails which comply with the expectations of current NHS safety guidance on preventing patient falls and entrapment (MHRA 2006; NPSA 2007). When not in use, they rotate underneath the bed and are stored beneath the bed base, meaning that there is no opportunity for them to be lost, nor any expectation that they need any separate storage space.

The pictures above demonstrate how the *Legacy* bed proved sufficiently adaptable to accommodate a wide range of volunteer patient sizes and presentations. The picture on the right demonstrates the deployment of the integral side rail.

The *Legacy* bed, like all of its predecessors**,** is essentially designed and intended for adult-sized bodies. The appropriateness of using this bed within paediatric complex care scenarios will require an individualised risk assessment by the paediatric care team. Older adults are increasing in numbers within the current acute SCI and complex care patient population (MASCIP 2011). The project group determined that during the trial periods, attention should be made to the comfort and security of older adults. Particular attention should be paid to any feelings of disorientation or confusion which may manifest during mechanical turning. Joint pain due to arthritis is a particular concern when turning older patients but in the patient experience, undertaking a 30^0 turn using the *Legacy* turning bed often proved more acceptable to the alternative experience of manual turning.

COMMAND AND CONTROL

Patient comfort and the risk of limb or device entrapment is a core concern of complex care clinicians when considering the use of a mechanical turning bed. In critical care, it is important that endotracheal tubes or associated tubing is not dislodged during turning. Numerous infusion and pressure monitoring lines are still peripherally sited and accidental extubation or removal of cannulae during turning is not uncommon.

In all previous models of spinal turning beds the side wings operated at the same time as the bed turned. This therefore required the nurse to monitor two separate movements in parallel. Only the command to turn was initiated by the health professional in charge of the turn, they had no control or influence over the speed or degree of movement of the side wing as this happened autonomously.

A key safety feature of the *Legacy* turning bed, requested by the clinical staff involved in the original design process, was that each bed movement should be designed to operate independently of the other controlled features and only at the direct instigation of the operator. This request has been successfully accommodated by Nexus DMS Ltd into the *Legacy* bed design and this therefore, as a unique operating system, has significant implications for the teaching and training of staff. Even staff experienced in the use of previous mechanical turning beds will need to review and revise their previous practices.

Bed controls are divided between those operated by feet and those operated by hands. Foot controls (see next page) enable the key functions relating to the bed base (raising & lowering height, Lateral turning, and Trendelenburg inclination).

Picture illustrates the position of foot controls around the base of the bed (see text)

Another unique feature requested by the design and development team is that all of the foot pedals are reproduced on all four sides of the bed. This means that the operating member of staff can be positioned in the most appropriate position relative to the task being performed. In previous bed designs, the operator was always expected to stand at the foot of the bed. When only one nurse was required to turn a patient this usually meant that the operator was out of sight of the patient for the duration of the bed movement. The layout of the pedals has also been prescribed so that, from right to left, they follow the usual sequence of events during routine patient turning - namely bed height adjustment, lateral turning, inclination. During practical turning exercises the MASCIP project team established that the pedals did not intrude upon proper foot placement for dynamic posturing and this was reflected in the REBA scoring. A detachable hand controller for these functions is stored under the bed in the event of any pedal failure. It is not intended for use as a patient-operated bed controller but if a scenario was suitably risk-assessed it may, on occasion, prove appropriate.

The hand operated functions are for the adjustment of the bed side wings and the employment of the back and leg raiser functions (see below). These control buttons are situated along the lateral sides of the bed.

The pictures above illustrate the hand-operated side controls of the bed (see text for detail). Note the protective guards designed to prevent accidental activation of a switch during patient turning or care delivery.

The back and leg raiser controls operate functions familiar in all electric turning and profiling beds. However, they are coloured red to indicate that for some SCI or complex care patients, these functions may have been 'locked out' for patient safety. The 'locking out' of these functions has been a key feature of mechanical spinal turning beds over many designs to ensure patient alignment is maintained where necessary. The process for 'locking out' this feature is described in a later section of this booklet.

The blue buttons control the deployment of the side wings of the bed. These can be deployed individually as either upper or lower sections (x1) or together (x2).

Patient bodies present as a wide variety of shapes and sizes but, until now, no previous design of turning bed has considered the potential to 'tailor' the support provided by the side wings of a turning bed to the shape of the patient before commencing the turn. Previously, nursing staff had to become proficient through experience at 'guestimating' the best position for the patient before undertaking a turn.

The project team found that whilst there is still a need to use sliding sheets to reposition some patients, this design feature has definitively reduced the frequency of this operation.

Pictures above: 'Adjust-to-fit' upper and lower side wings in use

As the *Legacy* bed mattress is made of visco-elastic (thermal contouring) foam, it is possible to move the side wings very close to the patient without causing undue discomfort.

CLEANING OF THE *LEGACY* BED

Familiarity with the position and function of the bed controls also reduces the time and physical effort required to clean the *Legacy* bed. By employing the appropriate controlled evolutions to full advantage, the MASCIP team determined that the bed could be cleaned to an appropriate standard within 10-15 minutes. The bed and mattress conform to NHS hard surface cleaning specifications and hypochlorite-based cleaning products. Because of the electrical components inherent within this product, deep steam or aerosol cleaning is not appropriate.

Picture 1: Team leader adopts head hold or optional shoulder pinning (see text below)

Picture 2: Tailoring the bed wings to the patient's body shape and comfort

As in the traditional protective spinal log rolling technique the turning team adopts the same positions as for a manual turn (Picture 1). The person holding the head is the 'team leader' and the person at the foot of the bed is the 'operator', who along with the team leader is responsible for monitoring spinal alignment during the turn.

The first step in preparing the patient to turn is to raise the side wings until they make appropriate contact with the patient. This is a unique feature of the *Legacy* bed and the project team were concerned that although adjusting the side wings is a relatively quick procedure, the time spent 'in hold' by the team leader could be perceived as excessive and possibly avoidable, particularly with an inexperienced team.

The possibility of avoiding the need to hold the head at this point was debated and it was decided that, given the fact that the bed was not actually turning at this point, then the team leader should individually risk assess their need to be actually holding the patient's head at this time. Often, during practice, it was found that the presence of the team leader or gentle shoulder pinning was sufficient and more comfortable.

Picture 3: Preparing to perform an acute (protective) mechanical log-roll

Picture 4: Turning in motion

With the bed sides set, and on the command of the team leader, the operator commences the turn. However, note that the rest of the turning team are only required to brace the patient during the turn (pictures 3-5), reducing the physical strain upon each member and improving patient comfort . The use of a turning bed to assist a spinal protective log roll is an established practice in complex care and a strategy to reduce wear and tear upon staff. Each team member must remain aware throughout the turn of the range of mechanical movement which occurs, the proximity of the moving frame to their bodies during a turn and any postural adjustment required.

Picture 5: Turning in motion

Picture 6: Patient after completion of turn with optional head block in situ. In actual patient, alignment is by the line nose-sternum-pubis - difficult to show with clothed volunteer.

The person taking the upper leg in lateral alignment during the turn is the only one effectively supporting a weight against gravity (picture 5). Again, this was reflected in the REBA scoring. At rest, the upper leg is supported on pillows or the foam blocks provided with the bed (picture 6). The MASCIP project team suggested that turning teams consider introducing this support before the turn commences on an individual patient basis. Following clinical trials, this has now become standard practice. Picture 6 also shows the patient at rest in 30^0 turn with an optional foam head block in situ to support the head, instead of a pillow or head-holding arm (see page 29).

Once a patient is at rest, a pressure-relieving side flap in the upper proximal side wing (indicated in Picture 6 by an arrow) can be released to enable the patient to make use of a functional hand control and arm to feed himself etc. The positioning of this device has been anatomically configured for spinal alignment. If it is to be employed for patients in whom spinal alignment is vital then they must be positioned at the outset so that the top of their head is no more than 2cm (two fingers width) below the top of the mattress. When positioned in this way they are guaranteed that their shoulder will remain supported by the bed frame when the side flap is released.

During the evaluation period, a range of foam blocks was tested on the basis that finding suitable pillows on a ward to support the patient in a turn can prove particularly frustrating. Following the project group assessment, Nexus DMS Ltd now provides six foam blocks with the *Legacy* bed as standard equipment to assist staff to support a patient's head and limbs during a turn without making any call on the ward stock of pillows. The foam blocks are covered in the same washable material as the mattress, conforming to NHS decontamination standards. The blocks are cheap to replace if required.

UNDERTAKING A MECHANICALLY ASSISTED LOG ROLL FOR HYGIENE AND SHEET CHANGE, BOWEL CARE AND ESSENTIAL SKIN CHECKING.

Discolouration of the skin is often the first indicator of skin suffering under physical pressure (NICE 2005). In hospital environments, whenever a pressure ulcer is detected in the early stages of its development, it usually resolves quickly if the patient is able to be positioned in bed in such a way as to avoid placing any further pressure on the affected area.

Utilising a turning bed to mechanically assist staff to undertake a 'complete' 90^0 log roll of an actual SCI patient was first demonstrated in the previous MASCIP Moving & Handling Guidelines (MASCIP 2009) utilising a Huntleigh *Atlas* turning bed and quickly became an expectation of any future turning bed design. However, in this model of turning bed, the side and base rotated to return the patient to supine at the same time. The MASCIP project team wished to evaluate whether the separate command and control would improve staff and patient comfort during this manoeuvre.

After several evolutions, the team decided that they had developed an appropriate procedure and a series of commands which satisfied the safety and comfort expectations for both staff and patients. As previously, the procedure was monitored and REBA scored by an experienced Manual Handling Assessor.

First, the turning team assembled and undertook to mechanically turn their patient into a 30^0 side tilt, as previously described. The team leader then gives the following instruction to the bed operator at the foot of the bed. "On my command, times 2 lower". This command instructed the operator to depress the blue x2 button positioned at the foot end of the bed and relative to the side wing proximal to the patients body. The patient, still in alignment, now begins to turn towards the turning team (see picture below).

This picture illustrates a patient experiencing a mechanically assisted log roll to 90^0, as described in the surrounding text.

At this point, the project team had previously determined that the command of the turn must transfer from the person holding the head to the second member of the turning team holding the shoulder and upper torso. This is because, as the patient approaches an approximate 50^0 - 60^0 inclination, this person will feel the forward momentum of the patient begin to decrease and so they are best placed to command the bed operator to begin lowering the mattress behind the patient.

They do so with the command instruction "Engage". Upon hearing this command, the bed operator begins turning the bed away from the patient by engaging the appropriate lateral tilt control with their foot, whilst continuing to lower the side wing which is supporting the patient. At the same time, the rest of the turning team, upon simultaneously receiving the command "Engage" will gently 'collect' the patient by gently drawing the patient towards them so that the forward momentum of the roll is restored. When the command "Engage" is called, appropriately, the patient will achieve a 90^0 angle of turn at the same time that the bed base achieves a level horizontal position. At this point, the team leader resumes command of the turn and instructs the bed operator to "Stop". The bed operator is then released to provide for a skin check, back wash, sheet change or bowel care as appropriate to the patient scenario (see picture to left).

With the patient now in a 90^0 lateral turn, the bed operator is released to perform the appropriate skin check or other cares as indicated. If appropriate, additional support can be provided to the team member holding the patient's leg in alignment through the use of pillows or foam blocks.

Guidelines on providing appropriate bowel management after SCI can be found on the MASCIP website at http://www.mascip.co.uk/guidelines.aspx.

This may seem a complicated procedure, but with appropriate instruction to the team and sufficient awareness and experience of the procedure being available within the two principal team leaders, then a turn which is safe and comfortable for both patient and staff can be achieved every time.

To return the patient to horizontal, the team leader will instruct the bed operator to return the patient to supine by the usual command of "Ready, Steady, Lower." At this command the bed operator will activate the appropriate foot and hand controls simultaneously in reverse so as to cause the side wing and mattress to raise together to return the patient to a 30^0 lateral turn, from whence they can be returned to a supine position and repositioned for supine lying or prepared accordingly for a further turn to the opposite side. Because there is no opportunity to 'tailor' the side wing to the body shape of the patient during this return manoeuvre, it is inherent upon the bed operator to 'intuit' when to discontinue raising the side flap to avoid causing the patient any slight pressure discomfort. Alternatively, where safe and appropriate, the team leader may afford command over this requirement to the patient as a "Stop" instruction to be given by the patient to the bed operator.

The MASCIP project team was unclear if there was a precedent within moving and handling legislation for changing the team leader within a manoeuvre. Surprisingly, although the current guidance does stipulate that: '*One person should plan and then take charge of the operation, ensuring that movements are co-ordinated'* (HSE 2004), there is sufficient scope within the guidance and its exemplars to suggest that as long as the change of leadership is pre-planned and communicated well within the team then there is no legislative barrier to the manoeuvre. Both of these manoeuvres have since been demonstrated in workshops at the 2012 conference of the National Back Exchange without eliciting any controversy. It has to be said that in the collective experience of all those who have practiced these two manoeuvres with some frequency that there is significant reduction in the postural strain experienced during a traditional manual log roll. Within the MASCIP project team there is a certain expectation that within this manoeuvre alone there is a significant potential for mechanical turning beds to reduce the incidence of non-specific back problems amongst NHS health care workers.

INTRODUCING THE EMBRACE-HOLD POSITION

The Embrace-Hold is a term the project team created for bringing both side wings up to turn (see photo below). At first it was perceived that this would be awkward for people with arthritis, a significant concern given the numbers of older adults presenting with SCI (MASCIP 2011) but the upper arm pressure relief flap proved more than adequate to restore comfort at the end of a turn. Patients with arthritic upper limbs should be informed before commencing a turn that there will be a short period of discomfort, which will be relieved at the end of the turn.

A similar concern was raised regarding feelings of confinement in patients with head injury, claustrophobia, confusion or compliance issues. Discussion with the relevant clinical governance experts demonstrated that the embrace-hold feature with side rails deployed, as an optional configuration of the bed, did not contravene Deprivation of Liberty guidelines. When the *Legacy* bed was actually trialled in neuro-surgical and neuro-intensive care areas the patient experience was wholly positive. Rather than feeling confined, patients felt more secure and comforted than when manually turned and left in position. In the majority of cases, patient anxiety and agitation regarding routine turning and repositioning actually reduced or was eliminated entirely after transfer onto the turning bed.

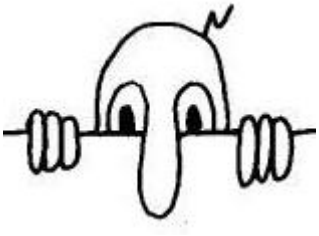
Picture illustrates the 'Embrace-Hold' feature of the *Legacy* bed. One consideration for use is to risk-assess whether the full employment of both side wings is sufficient for patient safety without the need to also deploy the side rails.

The project team perceived that in care situations where maintaining spinal alignment was not essential, such as acute and respiratory medicine and the management of acute medical neurodisabilities, this technique may enable a reduced number of nursing staff the opportunity to effectively increase the frequency of prophylactic turning for the 'at-risk' patient cohort by employing a regime of mechanically operated side-to-side turning by one or two practitioners without the need to call upon more colleagues.

The project team evolved a number of guidelines for this practice.

- Firstly, the patient should always be returned to supine between turns to check and adjust the support offered by the side flaps.
- Secondly, the operator or an assistant should maintain eye contact with the patient during turning.
- Thirdly, the patient should undergo a complete manual turn at least once every day, but ideally at every shift change, to inspect and document the underlying skin condition at handover.

This picture illustrates how, in cases where spinal alignment is not essential, but the patient is totally dependent on nursing staff to turn them, the *Legacy* bed can reduce the number of staff needed to perform the turn to two or even one. A key implication in this scenario is that the patient has been risk-assessed as to not require a skin check at every turn.



WOT, NO COMPUTER?

Previous models of 'spinal' turning beds have incorporated a computer to enable the bed to perform continuous or timed automatic lateral turning. This may have been a facility welcomed by staff but was rarely appreciated by patients. No warning tone, pre-emptive anxiety and absence of staff during operation were frequently quoted. Only in the most critical of care environments was there a guarantee of supervision during auto-turning. The project team also considered that a continuous turning facility would operate in opposition to the current Care Quality Commission expectations of minimum hourly checks on patients regarding condition, comfort, pain, posture and care needs (www.cqc.org.uk). With its proven potential to reduce the strain on nursing staff numbers, 'Care Rounds' operating within those scenarios where the patient does not require turning in alignment or where the support provided in turn by the *Legacy* bed has proved sufficient could enable nursing staff to offer the patient an opportunity for hourly patient turns if required.

Continuous Lateral Rotation Therapy (CLRT) is promoted for its benefits in acute respiratory therapy but the benefits it delivers are always tempered by the increased risk of pressure ulcers due to the repeated shearing experienced by the underlying skin. Selection of the most appropriate bed to support a therapeutic aim is vital. With the loss of the KCI *Rotorest* bed, respiratory and intensivists are mostly reliant upon pneumatic auto-turning mattresses to relieve the strain upon their nursing staff. These may be an effective solution for medical scenarios but their potential use in spinal trauma and SCI patients is limited by their inability to maintain spinal alignment.

SAFETY FIRST AND FOREMOST: AVOIDING UNPLANNED MECHANICAL ACTIONS.

All mechanical turning beds are faced with the potential hazard that during close handling procedures or care delivery, one or more control buttons may be accidentally activated by the pressure of a carer's body. Neither is it beyond possible consideration that a poorly informed health care worker might deliberately use the bed controls to move a patient into a condition inappropriate for the underlying condition or personal comfort. Similarly, a patient or visitor might seek to adjust the bed profile inappropriately in the absence of a member of staff.

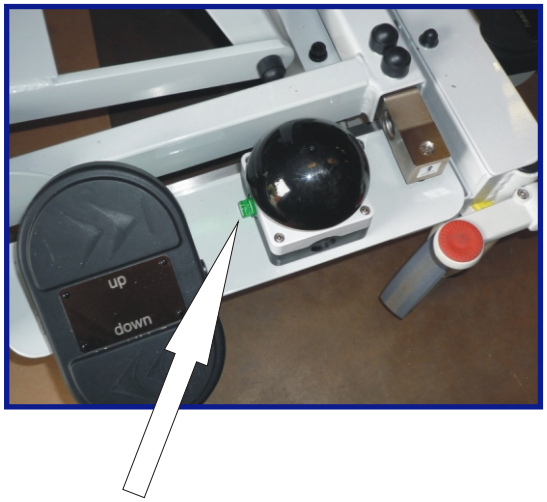
As previously explained, it is essential that some functions of the *Legacy* bed such as the back and leg raiser functions can be 'locked out', because when employed they will compromise spinal alignment. Similarly, if a patient is left unsupervised they must not be able to operate their bed controls inappropriately. In addition, if a patient falls out of bed onto the foot controls, they must not be able to lower the bed onto their body.

Locking devices as a standard feature can sometimes prove inconvenient for staff operating the bed, particularly if controlled by electronic timers. Also, if the locking system is prone to damage, the employment of the turning bed in its full capacity can be affected. The *Pegasus* and *Atlas* beds utilised a physical key locking system to 'lock-out' certain profiling functions. Unfortunately, examination of those beds still in use showed that most had lost their control keys and/or had broken or damaged control locks.

With this in mind, Nexus DMS Ltd have innovated a more robust function isolation system shown below. A pair of large 'safety keys' have been designed to slot into the frame of the bed. One is marked 'Full Function' and one is marked 'Restricted Function'. The 'Restricted Function' key disables the red buttons which control the back and leg raiser functions. As previously explained, these functions, if inappropriately employed, could cause significant patient harm in some scenarios. Total removal of both keys disables all functions but the bed battery continues to be charged. In situations where it is desirable to secure all bed functions (such as during visiting by relatives with children), the key in use can be removed from the bed and be carried by a nurse or placed in a bedside medicines cabinet. It is also appropriate to remove the key during storage and place it in the bed equipment trolley provided.

These pictures illustrate the use of the safety keys provided with the *Legacy* bed. The largest picture shows the 'Full Function' key in use on the bed.

Nexus DMS Ltd and the MASCIP project team have sought to provide sufficient layers of device security to counter all of the scenarios described on the previous page. During the evaluation period, and despite additional contact guards being provided for the buttons along the lateral bed sides, the team witnessed accidental activation of function buttons on several occasions. The bed was already provided with a red, foot operated 'emergency power off' button as required by the NHS for all electric mechanical devices (turning beds, hoists etc). This button cuts off mains and battery power to prevent any bed functions operating, but also cuts off mains power to the battery. The project team had hoped to utilise this feature to prevent accidental activation of a function during care activities. It would temporarily isolate the power to the function buttons where removing the function key would not be practical. However, the concern was that if not reactivated then the battery could be drained. Nexus DMS Ltd came up with the solution of providing a second foot operated button, coloured black, (see below) that would temporarily isolate mains power without affecting the battery charge. This was also provided with a visible light so that carers can see whether it is activated or not. This feature has proven itself in eliminating all consequential accidental bed function activations when utilised.



This picture shows the additional foot operated power cut-off button (see text above). Power indicator light shown by arrow - particularly useful in low light conditions.

This picture illustrates that in the event of a total bed failure, a manual operating system is in place to return the patient to supine. However, it is expected that this will only be used by Clinical Engineering personnel.

TRANSPORTING PATIENTS ON THEIR TURNING BED WITHIN HOSPITALS.

The project team proposes that care teams and portering staff should also give consideration to Embrace-Hold as an appropriate position during patient transportation between wards and departments.

Transporting the patient with the bed in a profiled turn means that the patient does not have to be turned supine for transport, continuing the therapeutic benefit of the turn until the very last minute. The reduced width of the bed was found to make steering and passage along busy corridors, through doors, and within lifts much easier.

When transporting critical care patients, a range of medical devices for monitoring and life support is required to accompany the patient. By involving Critical Care representatives within the evaluation team Nexus DMS Ltd was able to design in sufficient attachment and carriage points to ensure the carriage of all of the essential equipment required to support the in-hospital transfers of critical and complex care patients.

SUGGESTIONS FOR STORAGE

Space for equipment storage is always at a premium within hospital wards and departments and the project team also suggested to the design team that the embrace profile is an appropriate storage position for the bed when not in use. It would be inappropriate to store the case of attachments resting on the mattress so the available under-bed space was designated appropriate to store the case of attachments and the drip stand only when the bed is in storage.

In addition, it is important to reiterate to hospital staff to not pile additional equipment or attachments onto the mattresses of beds in storage as this can damage mattress covers or the underlying foam. Damage caused in this way is considered ‘user error’ and is subject to a penalty charge for replacement by the equipment provider and should therefore be considered an avoidable cost to the NHS. A protective cover has also been provided on the advice of the project team for when the bed is in storage.

To ensure that items stored or carried on the bed base were not accidentally crushed when the bed returns to normal operations, hazard warning signs were added to the bed base.

Pictures of the mobile storage case for the *Legacy* bed attachments (see text on page 24)

A BED OF MANY PARTS.

Previous turning beds have included a range of attachments. However, these were usually provided as supplementary equipment invoking additional charges. Nexus DMS Ltd is the first manufacturer to provide all attachments as standard within a single all-inclusive price. This provides a purchaser with the full range of treatment, handling and positioning options at the point of acquisition. In addition, many of these attachments were previously stored upon the mattress to keep them together with the bed, increasing the potential for compromising the mattress so Nexus DMS Ltd has evolved a wheeled storage case to contain all attachments (see pictures on page 23). The project group suggests that this standard should be adopted by other bed manufacturers.

SCI therapy teams were fully involved in the development of the bed and its attachments. They have long bemoaned the absence of appropriate attachments specifically designed to enable the arms of a SCI patient to be positioned in cruciform. Therefore, a pair of easily attachable arm-rests (see below) are provided as standard. This will avoid the use of bed tables which invade the circulating space around the bed. The project team found these arm-rests would also prove useful for positioning hands and arms for hand therapy, venepuncture and cannulation.

Pictures illustrate the ease of application of the arm-rests for therapeutic arm positioning

SILENCE IS GOLDEN

Noise at night is a major concern within inpatient health care environments (NHS Confederation 2010). One of the first comments made by the project team was how quiet this bed is during operation. In the past, it was actually the adjacent patients, rather than the one occupying the bed who commented on how noisy previous beds were, disturbing their sleep. In the current series of clinical evaluation trials, no patient has complained of being kept awake by a *Legacy* bed but several patients who had experienced being in the adjoining beds space to a previous model of turning bed expressed a positive appreciation of the low operating noise generated by the new bed.

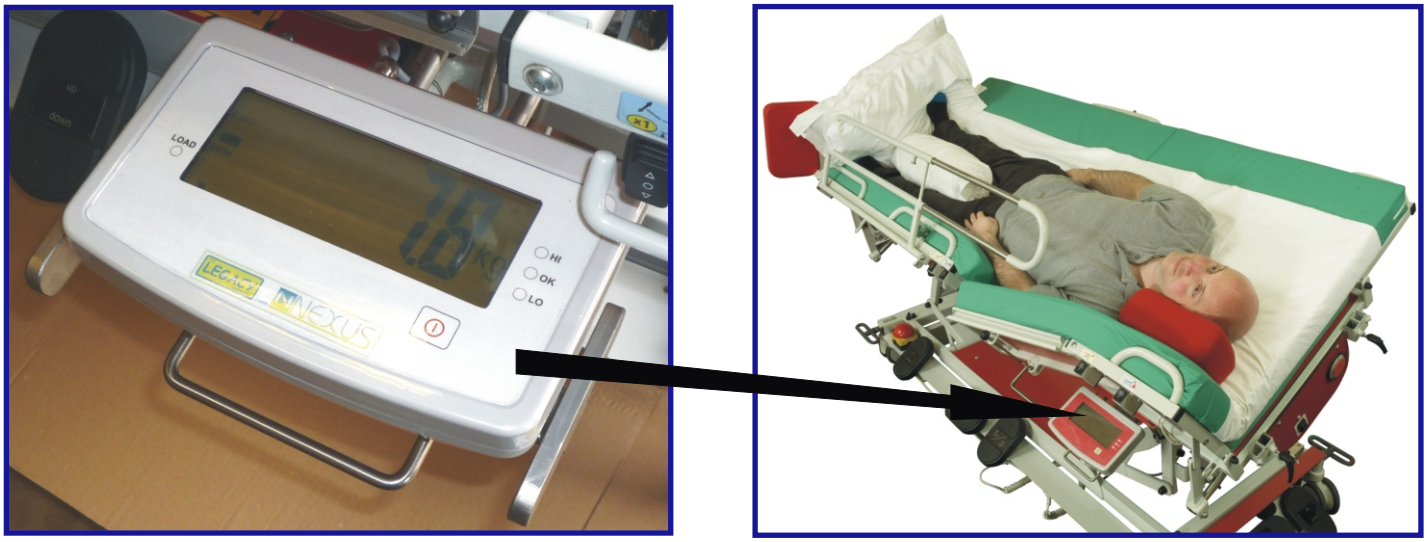
Another unique feature of the bed which proved particularly popular and beneficial amongst night staff during the clinical trials was the self-levelling feature. Night staff, being always conscious of noise generation when turning patients, were keen to praise the fact that one button could return the bed to level as they were conscious that in low-light conditions, the multiple pedal actions required to return the patient flat might result in erroneous movement or disturb sleeping patients.

Picture shows self-levelling button and lateral inclinometer. A vertical inclinometer for measuring Trendelenburg positioning is also present on each side of the *Legacy* bed.

WEIGHING IN TO COMPLEX CARE

With the recent emphasis on the potential risks and consequences of malnutrition in complex and critical care an integral weighing facility is now an essential rather than a desirable option in any specialist care bed. The *Legacy* bed comes equipped with a pull-out Class III integral weighing scale which is accurate to within 100g and conforms to current NHS device standards as outlined by LACORS (2009). The accuracy of operation of the scale is not affected by changes in posture and the patient can be accurately weighed in any position. It has a volatile memory so, in order to accommodate the various attachments which may be added or removed during care, Nexus DMS Ltd provide a list of weights for each removable part to assist clinicians to monitor weight as accurately as possible throughout the care process.

Within CQUINS, NHS hospitals are required to carry out a nutritional screening on every patient. This should be completed within 48 hours of admission and whilst estimated weights can be used, accurate results will come from an actual weight. The rationale for both BMI and percentage weight loss to be frequently used in screening tools is related to the effect that weight loss and low body weight have on patient outcomes. In order to allocate resources effectively to those most in need it is important to highlight those most at risk of malnutrition. Without adequate assessment and monitoring, weight loss can go unrecognised until dramatic changes have already happened. In such a scenario, outcome could have been improved if earlier nutritional support is instigated. In complex care, regular weight monitoring should be part of the overall nutritional monitoring plan.



Pictures show the bed's integral weighing system. This weighing system will maintain an accurate reading irrespective of the patient position when being measured.

A NEW KIND OF MATTRESS

"Pressure ulcers develop when capillaries supplying the skin and subcutaneous tissues are compressed enough to impede perfusion, leading ultimately to tissue necrosis.

Since 1930, we have understood that normal blood pressure within capillaries ranges from 20 to 40 mmHg; 32mmHg is considered the average. Thus, keeping the external pressure less than 32mmHg should be sufficient to prevent the development of pressure ulcers. However, capillary blood pressure may be less than 32mmHg in critically ill patients due to hemodynamic instability and comorbid conditions; thus, even lower applied pressures may be sufficient to induce ulceration in this group of patients." (Lyder & Ayello 2008)

The *Legacy* turning bed is the first model of turning bed to utilise a visco-elastic (thermal contouring) mattress. This mattress is of a design standard not previously encountered by the project group. Visco-elastic mattresses are well-proven in complex and critical care environments (Benbow 2008) but this particular design moulds to the body of the patient more rapidly and also recovers its form quicker than any previous model encountered in practice. This design feature has added a further degree of pressure relief to mechanical patient turning because, as the bed turns, the side of the patient experiencing the increase in weight is better supported than at any previous time. In addition, the uppermost half of the patient is now only barely in contact with the underlying mattress, providing a significant reduction in pressure distribution over this half of the body. So much so that a flat hand may pass easily between the skin and the mattress with minimum resistance. This mattress characteristic was also found to be beneficial to assist the insertion of sliding sheets, patient transfer sliding boards, scoop stretchers (see later) and x-ray plates with less resistance and improved patient comfort.

In all of the patient trials to date there has been no report of any pressure ulcer development. This particular mattress was perceived to be particularly beneficial for reducing the incidence of occipital pressure ulcers within critical care patients. In addition, unlike many other forms of visco-elastic mattress, this particular formula of foam does not generate the same exothermic heat during its chemical contouring process. Formal pressure mapping of the *Legacy* mattress has not been attempted to date but could form part of later evaluation studies.

Thermal contouring foam mattresses are appropriate for acute spinal injury and SCI patients but require careful monitoring of the patients' heels to ensure that they are generating enough body heat to transform the underlying foam to its gel state. For this reason, even with this new mattress, pillows are still required to support the heels of SCI patients completely free of the mattress (see right). The *Legacy* is also supplied with an adjustable length foot board (from 168cm to 198cm) to assist in the prevention of foot drop and, hopefully, reduce the number of pillows normally required to undertake this.

Picture illustrates the fact that most SCI patients do not generate sufficient heat in their lower limbs to gain the full benefit of the pressure-relieving properties of a thermal contouring (visco-elastic) mattress and will require their heels to be supported off the mattress surface using pillows. The feet of SCI patients should also be 'blocked' with pillows against foot drop.

Guttmann indicated specific concepts in the design of an appropriate divided mattress and platform for a turning bed, namely that it should: "*allow movement of the patient to take place without compressing the surface of the mattress and thus avoid creases on the patient's body.*" (Guttmann 1967). Unfortunately, there was still a significant potential for tissue shearing in the earlier turning bed models, which was addressed by the nurses manually readjusting the patient's position between turns. As part of the design and development process, Nexus DMS Ltd developed and trialled three completely different mattress systems with patients at the National SCI Centre, Stoke Mandeville before settling on the current design and materials.

Contd/

Nexus DMS Ltd has improved even further on this intent by developing a double-layered mattress system wherein the patient is nestled in the visco-elastic upper mattress which, during turning, moves laterally over the second, separate, lower mattress which is made of a more compact foam. This eliminates any potential for shearing of the patient's tissues under changes of weight-bearing during turning. When observing the mechanical 30^0 patient turns, the team noted that whilst there is lateral soft tissue movement of abdominal contents and breast etc. at no time was there any observed loss of spinal alignment. Skeletal markers (nose, sternum, pubis, hips) remained aligned when the patient completed the turn.

Picture shows the unique dual-layer mattress system described above. The patient lies within the upper visco-elastic mattress which, during use, glides over the surface of the lower mattress, eliminating shearing of the patient skin. This mattress system is provided as standard for the *Legacy* bed.

During the testing and trialling of this mattress system, the development team was at pains to stress that at the midpoint during side to side turns, the patient needs to spend a few minutes before the turn continues. This is so that the mattress can re-contour itself to the weight and profile of the whole body. At this point there are some tasks which the nurse can undertake such as transferring the catheter drainage bag.

As for all mattresses, external fixation devices carry the risk of perforation or tearing of the protective mattress cover of the non-standard mattress of a mechanical turning bed. For this reason, consideration should be made within purchasing plans for a *Legacy* bed to store a number of spare mattresses on site as a precaution.

CERVICAL TRACTION - A LOST ART RESTORED?

"Cervical traction is a non-invasive method for the reduction and stabilisation of spinal fractures and dislocations. It is the method of choice for patients unsuitable for surgery or for whom surgery is not a priority. Guidelines for the appropriate application and maintenance of cervical traction are well established in most trauma and critical care Environments." (Harrison & Ash 2011).
A number of orthopaedic and spinal surgeons contributed their knowledge and experience towards developing and revising the design and use of the cervical and lower limb traction systems provided as standard within the *Legacy* bed equipment portfolio.

Picture shows the initial fitting of the cervical traction kit for the *Legacy* bed.

During reduction of a cervical dislocation, traction weights are applied under x-ray guidance. During mobile x-ray procedures the bed did not cause any obstruction or challenge for the radiographer. The weights are then increased in stages, and the x-rays repeated until a successful reduction is achieved. During this time, the consultant may manually adjust the angle of pull of the traction cord, and/or the angle of the patient's neck between extension and flexion. He may also request changes in the foot down or head up angle of the patient's bed to alter the amount of counter traction provided by the patient's body. With so many staff circulating around the patient's bed, care must be taken not to dislodge a traction weight onto a foot (Harrison & Ash 2011).

The multiple switches and pedal positions provided on the bed reduce the amount of staff movement between stations whenever positional change of a patient is required during procedures such as establishing and adjusting cervical traction, bedside monitoring or respiratory and critical care devices.

After reduction of the dislocation, the traction weight and bed angle will be reduced to support a minimum maintenance weight of only a few pounds. This weight must never be removed during turning unless it is first replaced by manual traction and/or a suitably prescribed cervical collar.

Picture illustrates one method for adjusting the cervical traction kit for the bed.

During the project group evaluation of the bed it was suggested that a second, separate, nylon runner wheel should be fitted at the base of the traction stem to prevent the traction weights swinging and the traction cord from fraying during use. This has now been added to the standard equipment portfolio for this bed.

As well as a cervical traction kit, the *Legacy* equipment portfolio includes provision for bilateral lower limb traction also. During mechanical turning, whether using it for cervical or leg traction, the traction post extensions ensure that the traction cord continues to run free over the nylon runner wheel. The traction weight should never be routinely removed during turning. When moving a bed-fast patient between departments please ensure that the traction weight does not pendulum too much from side to side. Never use any part of the traction apparatus as a handhold or arm rest when moving the bed, turning the patient or undertaking care procedures. (Harrison & Ash 2011)

These two pictures show how the *Legacy* bed standard equipment portfolio continues to provide the popular head supports first developed by Sir Ludwig Guttmann as a method to maintain lateral cervical spinal alignment during mechanical turning.

Picture demonstrates that a unique feature of the *Legacy* bed is its ability to provide for kyphotic traction because the traction set is attached to the profiling mattress base.

Picture demonstrates the leg-raiser function to ease ergonomic strain on care staff engaged in activities involving the lower limbs such as passive movements, washing or moisturising skin or applying anti-thromboembolism stockings. It can assist in the use of lower limb traction.

IMPROVING ACCESS FOR FAMILY AND PEER SUPPORT IN COMPLEX CARE SCENARIOS

The lower tilt-turn profile of the *Legacy* turning bed offers further opportunities to improve the visual horizon for the patient, particularly regarding visitors to the bedside.

Community Peer Support is a scheme recently introduced by the Spinal Injuries Association to provide Peer Support Officers who can visit patients in hospital to provide information, education and advocacy services. Our picture below shows how the bed can be positioned to enable a Peer Support Officer to engage in comfortable conversation with a patient during bedrest. The presence of a peer during the early stages of injury and rehabilitation has been shown to have a significant impact on the ability of a newly injured person to come to terms with their new situation.

The pictures show how the bed can be contoured with 30^{0} lateral tilt and 17^{0} reverse Trendelenburg positioning to enhance the patient viewing profile for seated visitors. It is illustrated here by a member of the Spinal Injuries Associations Peer Support Team (www.spinal.co.uk/page/Peer-Services). This position has also proved useful for nursing staff when feeding patients and for therapists such as for Occupational and Speech and Language therapy. Social Workers, Ward Clerks and Discharge Coordinators are often required to engage in more lengthy interviews with patients and can work in greater comfort from this position.

COMPATIBILITY WITH OTHER EQUIPMENT: SCOOP HOIST TRANSFERS TO OTHER SURFACES

The pictures below illustrate how the MASCIP project team ensured that the *Legacy* bed provided no barrier or obstacle to the employment of other essential equipment routinely used in complex care scenarios. In this instance the use of a scoop-hoist system for patient transfer between flat surfaces. Positioning and use of all of these devices was REBA scored and monitored throughout for enabling safe posture.

SLIDING TRANSFERS TO OTHER SURFACES

It is standard practice when moving a dependent patient up/down the bed with a sliding sheet to use the reverse Trendelenberg feature to reduce the strain on carers. With a mechanical turning bed there is the further option to use the lateral tilt facility for surface-to-surface transfers using a transfer board and slide sheets (see picture below).

Patients with complex injuries require multiple transfers between flat surfaces during their management, making best use of the lateral tilt facility reduces the physical strain on staff more than during a traditional level surface transfer.

Additionally, with the *Legacy* bed, the ability to independently raise the side wing provides a reassuring barrier cushion for both staff and patient. Positioning and use of all of these devices was REBA scored and monitored throughout for enabling safe posture.

Picture shows the internal transfer of a complex care patient using a scoop stretcher, transfer board & sliding sheets as described above.

During the clinical trials this facility was most appreciated by CT radiographers, surgical teams, theatre porters and theatre recovery teams. With previous models of mechanical turning bed the patient had to transfer onto a transfer trolley before going to theatre or CT. Using this new transfer facility, the patient could go to CT or theatre on his bed and be transferred directly from/to his bed within the department. This removed the need for staff to undertake two lateral transfers from every patient journey to theatre or CT.

EVALUATING THE PATIENT AND PROFESSIONAL EXPERIENCE OF TRIALLING MECHANICAL TURNING USING THE *LEGACY* BED.

In order to test the viability of the concept of a complex care bed, the project team members and staff within the pilot hospital departments completed and returned detailed evaluation forms and participated in feedback interviews. The forms collected information on general bed utility as well as compatibility and functionality regarding condition-specific care requirements. Where appropriate, patient and family experiences were collected and incorporated into the design and development process.

Experiences with actual spinal cord injury patients

Trials were conducted with actual SCI patients in five English SCI Centres where previous models of mechanical turning bed were regularly employed in the care of patients with actual SCI. These were the NHS staff with the greatest experience of mechanical turning beds and these staff demonstrated the most appropriate appreciation of the new features identified and designed by their peers to enhance the patient and staff experience of mechanical turning. From the evaluation forms returned it was apparent that the transition from a spinal turning bed to a complex care bed had not compromised the care of the original patient population intended to benefit from this medical device. The involvement of three SCI Centres within the original development and testing of the bed and its unique mattress system had ensured that the bed was fit for purpose for both SCI patients and the multi-professional teams caring for them.

Experiences with spinal injury patients without neurological compromise

Trials were conducted in three orthopaedic spinal surgery centres where previous models of mechanical turning bed were regularly employed in both the conservative and post-surgical management of orthopaedic spinal injury patients. The orthopaedic teams were keen to evaluate the bed because many complex spinal injury patients have the potential to acquire a SCI secondary to manual turning and in the past have often remained unturned for fear of mechanically compromising the spinal cord. The spinal orthopaedic teams also played a vital part in refining the kyphotic traction system as illustrated on page 29.

Experiences with multiple trauma patients

Trials were conducted in three major Trauma Centres where previous models of mechanical turning bed were regularly employed for spinal/SCI patients but where there had been no previous experience of using a turning bed for patients with multiple injuries which did not include the need for spinal protection. Positive evaluations were returned by all. In every case the staff were surprised that so little research had been done into the holistic benefits of turning beds for major trauma patients and MTC staff.

Experiences with general intensive care patients

Second to SCI Centres, the greatest current use of mechanical turning beds is within critical care facilities, particularly those established within Major Trauma Centres. 21 critical care units have so far evaluated the *Legacy* bed and report that, in their opinion, several patients have now benefited and survived life-threatening injuries due to the provision of mechanical turning. The critical care consensus is that they have managed to wean a range of critical care patients from ventilation support much faster than if they had been nursed on a conventional bed, thereby expediting their long-term recovery and discharge from intensive care. They estimate that mechanical turning has enabled their trial patients to wean from the ventilator by an average 4 days earlier than expected. This is not an absolute finding established by a formal research project but a clinical consensus established at interview between the trialling units. Given the pressures upon the national network of critical care beds, the involved critical care teams were unanimous in their suggestion that the Intensive Care Society should give serious thought towards enabling a prospective academic research project to evaluate the contribution and benefits of mechanical turning in relation to the enhanced weaning of ventilated patients. Nexus DMS Ltd has indicated that they would be prepared to resource a small pilot study.

Experiences with acquired brain injury and neurosurgery

In clinical evaluation trials Embrace-Hold has proven to be surprisingly beneficial in the management of acute acquired brain injury patients. These are patients with severe dependency needs requiring several nurses to perform routine turns but often without the requirement for maintaining spinal alignment. The neuroscience centres trialling the *Legacy* bed found that patients suffered less distress and less increase in ICP when turned on the bed compared to manual turning.

Following any primary brain injury, the aim of subsequent management is the prevention of any secondary brain insult including hypoxia, hypercapnia, hypotension, hyperglycaemia and metabolic acidosis - all these systemic factors contribute to an increasing raised intracranial pressure (↑ICP) in the absence of auto-regulation (Hickey, 2008).Whilst there is a raft of invasive medical interventions that may help to control the ↑ICP, judicious positioning of the patient ensuring that venous drainage from the internal jugular vein back to the heart can help minimise significant rises in ICP. In addition, elevation of the head to 15^0 - 30^0 and avoidance of extreme hip flexion occurring when side lying, is similarly associated with a mean decrease in ICP levels (Mestecky, 2011). The *Legacy* bed enables multi-positional rotation of the patient over a number of axes, including lateral rotation to 30^0, head and leg elevation, reverse Trendelenburg (head up) as well as a number of other functionalities that enhance therapeutic treatments.

The nursing care of brain injured patients presents many challenges and a thorough knowledge of the dynamics of ICP and the factors associated with its increase is essential. The effects of environmental stimuli on ICP is recognised, especially the importance of minimising unpleasant physical stimuli such as attending to basic hygiene needs, changing position to protect pressure areas and protecting surrounding skin surfaces. Using the *Legacy* bed, the neuroscience teams were able to move these complex patients using the minimum number of staff, with the minimum of interventions changing the patients position gently and gradually, thereby releasing nurses to care for other patients. As confidence and competence with using all the functions of the bed increased, the teams started transferring patients directly onto the bed from the theatre table to optimise patient management from minute one, day one.

Experiences with pelvic injuries
Patients with pelvic injuries are another group associated with a high potential for pressure ulcers due to being turned inadequately or insufficiently due to the perceived risk of displacing bony fragments and causing additional complication (Walker 2011). One pelvic surgeon within an MTC agreed to trial the bed with 2 patients during both the pre and post-surgical periods. The evaluation of the bed was positive from both professionals and patients alike.

Experiences with complex surgery patients
A number of patients who had undergone complex or reconstructive surgery, amputation and joint replacement were included within the clinical trials. The bed proved to be adaptable to all circumstances and whilst patients were sometimes unsure of its benefits, clinical staff were certain that on the basis of their previous experience the patient pain and discomfort experienced during routine turns and transfers was, in their opinion, significantly reduced.

Experiences with Acute (Adult) Respiratory Disease Syndrome (ARDS)
Evaluating the bed as an aid within respiratory care exposed the potential for clinical teams to continue to develop new ways of using the bed. The recommended treatment is to nurse the patient prone (Ball 1999). Pape, *et al* (1998) demonstrated that the increase in ARDS in at-risk patients with traumatic injuries can be significantly reduced by implementing a programme of routine and regular turning from an early stage after admission. Turning also improved systemic oxygenation and overall survivability in these patients. For this reason the neurosurgical and critical care teams suggest that all at-risk patients are admitted initially into a turning bed pending later review.

One critical care centre, after purchasing a *Legacy* turning bed, actually demonstrated that by positioning a ventilated ARDS patient prone before turning them on the bed in the 'embrace hold' position they were able to avoid transferring that patient for ECMO (Extra-Corporeal Membrane Oxygenation). This was an innovative use of the bed and one which had not been previously considered by the design or evaluation teams. The critical care team was impressed because the patient recovered without the need for transfer to an ECMO centre. They also calculated that the cost of a single ECMO treatment is approximately £25,000. This is almost the full cost of a *Legacy* bed, suggesting that through their innovative use of a new bed, they recovered the cost of this bed within a single patient episode. The critical care team consider that this technique provides another layer of care for these patients between the onset of ARDS and the decision to provide ECMO therapy and are seeking to promote this strategy within the critical care network. ECMO is an expensive end-stage treatment for ARDS patients with only a few UK hospitals providing this treatment for adults. Transfers of ARDS patients over such long distances is extremely hazardous and usually requires the despatch of a specialist helicopter retrieval team from the ECMO Centre. You can find out more about ECMO at www.elso.med.umich.edu.

Experiences with complex or major trauma during pregnancy

Trauma during pregnancy is an extremely complex care scenario, not least because there are two patients to provide for - the mother and her unborn child. Pregnant patients beyond 20 weeks gestation should not be left lying supine because, in the supine position, the pregnant uterus can compress the vena cava, reducing the venous return to the heart. This produces hypotension which can impair both the maternal and foetal circulation (Hodgetts & Turner 2006). The risk is greatest during the third trimester. In actual or uncleared spinal/SCI patients presenting during the later stages of pregnancy the foetus can be displaced from this position manually, or by turning the patient into a 30^0 left-tilted position. Additionally, in the later stages of pregnancy the foetus can compromise respiration and there is an increased risk of aspiration of gastric contents.

During the clinical trials of the *Legacy* bed, the evaluation team was fortunate to discover a number of midwives embedded within Major Trauma Teams. Two of these midwives were found to be in their third trimester of pregnancy and volunteered to experience and evaluate mechanical turning and positioning on the bed. The overall evaluation was that the bed would be of great benefit to pregnant women whose care required a significant period of bedrest or immobility such as in neurotrauma, spinal cord injury, multiple trauma or critical care scenarios. The bed was able to adequately support the body and abdomen of a patient in the later stages of pregnancy and the positioning of the foetus was also evaluated as being adequately displaced following a 30^0 left lateral turn with 17^0 reverse Trendelenburg inclination. Short periods of right lateral turning are possible to relieve pressure on the left side but the midwifery representatives, as well as the volunteer patient, were satisfied with the durability of pressure relieving properties of the visco-elastic mattress. In addition, the evaluating midwives found that the inclined position also improved the symptoms of gastric reflux and diaphragmatic impairment. The benefits of mechanical turning beds is something never previously evaluated in general midwifery care. Our volunteers felt that this is something which should be researched in more detail.

NEW THOUGHTS ON CARDIAC ARREST RESPONSE

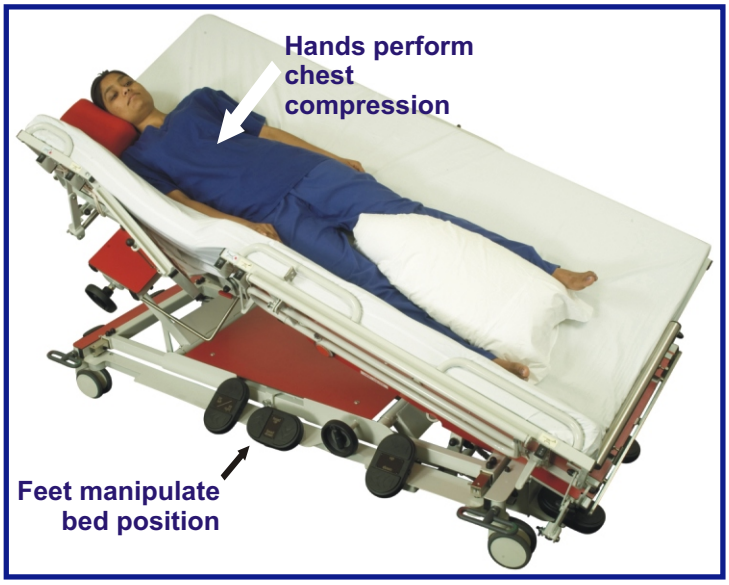
A standard feature found on all NHS beds, including mechanical turning beds, is the manual CPR release lever (see picture). This is an NHS design requirement for a 'controlled' release mechanism to return a sitting or profiled patient to supine. Lifting this lever causes the back and leg raiser supports to collapse under the weight of the patient, allowing the medical team ready access to the patient for CPR. The descent of the patient is partially slowed by gas struts. However, the MASCIP project team noted that given the complex injury management and specialist surgical procedures invested in the care and management of SCI and related complex care patients, a rapid descent and sudden impact might be hazardous to the underlying condition and the presenting patient condition. Although not testifying specifically to this point, these concerns may be partly reflected in the guidance provided by the UK Resuscitation Council (UKRC 2009) which suggests that in the absence of a powered CPR function, two healthcare workers may have to consider taking position to support the backrest before the CPR lever is released so that they can then lower it to a supine position in a more controlled descent.

The MASCIP project team was familiar with these concerns and was stimulated during the evaluation process to consider whether the new command and control format available within the *Legacy* bed would enable the development of a new technique to return a profiled complex care patient to supine utilising powered functions entirely. The MASCIP project team demonstrated in a timed simulated patient collapse that, by employing the individual back and leg raiser buttons on the side of the bed, it could return a fully profiled patient (90^0 back raiser with 40^0 leg raiser) to flat supine within 16 seconds of the user declaring a collapsed patient scenario. The optimal bed height for performing CPR is one which positions the patients chest level between the knee and mid-thigh of the person performing chest compressions (UKRC 2009). The MASCIP project team then determined that by simultaneously using the foot pedal to lower the bed, a single practitioner could both unprofile a bed and set it to an appropriate height for CPR within the same 16 seconds.

However, both the CPR lever and the bed profiling buttons only reduce the patient profile setting. They have no influence over the lateral rotation or Trendelenburg functions of the bed and so neither will return the bed to supine from a lateral rotation or Trendelenburg inclination if either or both were employed alongside the profiling functions. In this situation, the team determined that by using the foot pedal to rotate the bed to flat supine at the same time as unprofiling the bed, a single practitioner could both unprofile and de-rotate the bed. With a slight adjustment of their feet, the operator would then reverse any Trendelenburg inclination. This would still take only a little longer than16 seconds (depending on the degree of inclination).

If two members of staff attended the collapsed patient, then by simultaneously depressing the self-levelling and profile buttons, two operators could, between them, set a *Legacy* bed to both flat supine and an appropriate height to commence CPR within the same 16 seconds.

The MASCIP project team enquired as to whether a single 'CPR' button could be provided which could perform all of these manoeuvres automatically at the same time. The Nexus DMS Ltd team is considering this suggestion but has already determined that if it was employed, it could not be a 'press and forget' because of the restrictions of Medical Electrical Equipment (BS EN60601). If such a button was provided it would have to be manually held down until all of the bed evolutions had been completed.



This picture illustrates a suggestion which arose from discussions during clinical trials regarding the possibility of the responder to a collapsed patient scenario commencing CPR actions whilst simultaneously returning the *Legacy* bed to supine. Until evaluated in combination by resuscitation and manual handling experts it has no provenance in research or clinical practice but is another illustration of how innovative product design can stimulate clinicians to review their previous practice expectations.

CONCLUSION

The MASCIP project team believes that they have demonstrated that despite there being a limited research evidence base upon which to draw, there is a sufficient intention and a clinical care consensus to support the continued use and development of mechanical turning beds for use within critical and complex care scenarios for the foreseeable future. Within the development and evaluation process, which saw the *Legacy* bed accepted into the 2012 NHS Purchasing Catalogue, the MASCIP project team can conclude that the NHS has endorsed a new design of mechanical turning bed that was first and foremost designed to satisfy the current and future needs of clinicians to move beyond the traditional design parameters and the restricted perceptions of patient suitability in the way in which Guttmann always intended.

Current austerity measures may continue to frustrate the purchase and employment of mechanical turning beds, both within and beyond critical and complex care environments. However, Nexus DMS Ltd has taken on board both the findings of this MASCIP report and the regard and enthusiasm for turning beds evidenced through the project as a whole across a wider range of clinicians than previously. As a result, Nexus DMS Ltd is currently exploring leasing and hiring partnerships with the key UK hospital bed providers to at least provide sufficient mechanical turning beds for within the national Major Trauma network.

APPENDIX:

Risk Assessment (HSE 2012)

There is a degree of 'risk' in all aspects of normal life e.g. crossing the road, using a lawn mover, flying, mountain climbing etc.

Risk is a measure of the likelihood of injury, damage, loss or harm occurring. When considering manual handling risks, you usually think about injury or harm to an individual, although there may be other losses to consider e.g. loss of reputation of the Trust if a patient is injured during an incorrectly performed manual handling task.

Risk assessment is a measure of the likelihood of the risk occurring and the consequences of that if it does e.g. when crossing the road, you make a judgement about the speed of the oncoming traffic, its distance away, the distance to the opposite kerb and the speed which you can get there. You are also going to take into account the likely injury or harm to yourself if you don't make it to the other side in time! This is an informal risk assessment that you probably carry out regularly without even realising.

A control measure is a system put in place to address an identified risk.

Risk assessment is ultimately a balancing act. Working out how likely the risk is to happen and what the impact of that will be if it does. The law does not state that all risk must be eliminated. Risk is an essential part of our everyday life. In the working environment, risk must be reduced 'so far as is reasonably practicable' - this does not always mean it must be eliminated!

You must be careful when introducing control measures to address a risk issue that it does not introduce different risks e.g. by providing additional storage to reduce trip hazards in an area, this may introduce postural risks due to excessive reaching / stretching

The Manual Handling Operations Regulations which came into force on 1st January 1993 (HSE 2004), set out a hierarchy of measures that employers must follow to reduce the risks from manual handling.

- Avoid hazardous manual handling operations so far as is reasonably practicable. This may be achieved by not doing the task, doing the task in a different way or using equipment to undertake the task
- Assess any hazardous manual handling operations that cannot be avoided. If the task cannot be avoided then the way in which the task is carried out must be assessed to highlight any risks
  e.g. identify that there is a risk due to the weight of the linen bags.
- Reduce the risk of injury so far as is reasonably practicable. When the risks have been highlighted, then plans must be put in place to remove or reduce the risks.
- Review the assessment if there is reason to suspect it is no longer valid or, there has been a significant change in the manual handling operations to which it relates. All risk assessments must be reviewed periodically, including after untoward incidents, when there are changes in the way a job is carried out or in the environment.

For all manual handling tasks with a risk of injury, the risk assessment should be undertaken and recorded and made available for all staff.

For a manual handling risk assessment there are specific criteria to be included in the assessment. These are:-

- Task
- Organisational Factors
- Individual Capability
- Load
- Environment
- Equipment

Problems to look for when making an assessment	Ways of reducing the risk of injury
The tasks, do they involve: • holding loads away from the body? • twisting, stooping or reaching upwards? • large vertical movement? • long carrying distances? • strenuous pushing or pulling? • repetitive handling? • insufficient rest or recovery time? • a work rate imposed by a process?	**Can you**: • use a lifting aid? • improve workplace layout to improve efficiency? • reduce the amount of twisting and stooping? • avoid lifting from floor level or above shoulder height, especially heavy loads? • reduce carrying distances? • avoid repetitive handling? • vary the work, allowing one set of muscles to rest whilst another is used? • push rather than pull?
Work organisation factors: • is the work repetitive or boring? • is work machine or system-paced? • do workers feel the demands of the work are excessive? • have workers little control of the work and working methods? • is there poor communication between managers and employees?	**Can you**: • change tasks to reduce the monotony? • make more use of workers' skills? • make workloads and deadlines more achievable? • encourage good communication and teamwork? • involve workers in decisions? • provide better training and information?
Individual capacity, does the job: • require unusual capability eg above average strength or agility? • endanger those with a health problem or learning/physical disability? • endanger pregnant women? • call for special information or training?	**Can you**: • pay particular attention to those who have a physical weakness? • take extra care of pregnant workers? • give your employees more information eg about the range of tasks they are likely to face? • provide more training? • get advice from an occupational health advisor if you need to?
The loads, are they: • heavy, bulky or unwieldy? • difficult to grasp? • unstable or likely to move unpredictably (like people)? • harmful eg sharp or hot? • awkwardly stacked? • too large for the handler to see over?	**Can you make the load**: • lighter or less bulky? • easier to grasp? • more stable? • less damaging to hold? • if the load comes in from elsewhere, have you asked the supplier to help eg provide handles or smaller packages?
The working environment, are there: • constraints on posture? • bumpy, obstructed or slippery floors? • variations in levels? • hot/cold/humid conditions? • gusts of wind or other strong air movements? • poor lighting conditions? • restrictions on movements or posture from clothes or personal protective equipment(PPE)	**Can you**: • remove obstructions to free movement? • provide better flooring? • avoid steps and steep ramps? • prevent extremes of hot and cold? • improve lighting? • provide protective clothing or PPE that is restrictive? • ensure your employees' clothing and footwear is suitable for their work?
Handling aids and equipment: • is the device the correct type for the job? • is it well maintained? • are the wheels on the device suited to the floor surfaces? • do the wheels run freely? • are there any brakes? If so, do they work?	**Can you**: • provide equipment that is more suitable for the task? • carry out planned preventative maintenance to prevent problems? • change the wheels, tyres and/or flooring so that equipment moves easily? • make the brakes easier to use, reliable and effective?

POSTURAL ANALYSIS

There are many postural analysis tools available for use in a variety of work situations. Hignett and McAtamney (2000) developed the Rapid Entire Body Assessment (REBA) postural analysis tool, which was specifically designed to meet the needs of the health care and service industries, where the postures adopted are often very unpredictable. A multi disciplinary team of ergonomists, physiotherapists, occupational therapists and nurses, who between them collected and coded over 600 postural examples, developed the tool.

The resultant tool incorporates static and dynamic muscle activity, human - load interface (coupling), and gravity assisted upper limb position. It also includes a score for rapidly changing and unstable postures. Ultimately it aims to give an overall score indicating the urgency with which any action needs to be taken.

REBA however does not score the whole activity, it scores snapshots of activity throughout the task. This is the postural analysis tool chosen for this study as the National Back Exchange (NBE) member advising the MASCIP project team felt it was relatively simple to undertake and it would clearly reflect the difference in postures between the various tasks assessed. It is also the postural analysis tool used in the recently updated Handling of People 6th Edition (Smith 2011), therefore is recognised and understood by many of the people in the Back Care / Manual Handling field.

For this study, the most 'risky' aspects of the task were photographed and assessed using the REBA tool. In some instances, assumptions were made during the analysis of the phase of movement of the task, and the angles of some of the limbs which may not have been clearly evident in the picture. Although the majority of the photographs were assessed by one NBE member experienced in the use of the REBA tool, a random selection were checked for consistency of scoring by a second experienced NBE member. For the photographs, models were used, not real patients, although the majority did involve an actual SCI individual who was more able to accurately reflect the normal movement of someone with that type of injury. The environment used for the photographs was spacious and not necessarily reflecting the normal ward environment, and pressure of time and other work did not impact on the handling procedures used.

THE PROJECT TEAM

The Project Team was comprised as follows:

1) The original team of demonstrators, drawn from various hospitals and clinical disciplines, directed by Paul Harrison, Clinical Development Officer at Princess Royal Spinal Injuries Centre, Northern General Hospital, Sheffield, alongside the Technical and Sales Teams from Nexus DMS Ltd.
2) The SCI teams at Robert Jones and Agnes Hunt Hospital Oswestry, NSIC Stoke Mandeville and Princess Royal Spinal Injuries Centre, Sheffield who participated in developing the initial design test-bed through to the current production model of the Nexus *Legacy* complex care turning bed.
3) The wide range of NHS hospitals that trialled the bed and provided valuable feedback, leading to the adoption of important design changes and the product's acceptance into the NHS catalogue:

2010: NSIC Stoke Mandeville
2011: Aberdeen Royal Infirmary; Royal Hallamshire Hospital, Sheffield; Norfolk & Norwich University Hospital; James Paget University Hospital, Great Yarmouth; Addenbrooke's Hospital, Cambridge
2012: Leicester Royal Infirmary; Royal Liverpool Infirmary; Queens Medical Centre, Nottingham; Princess Royal Spinal Injuries Centre, Sheffield; Stepping Hill Hospital, Salford; Queen Elizabeth Hospital, King's Lynn; Royal Derby Hospital; Pilgrim Hospital Boston; London SCI Centre, RNOH, Stanmore; Royal Berkshire Hospital, Reading; Southampton General Hospital; Musgrave Park Hospital Belfast; Birmingham Heartlands Hospital; Queen Elizabeth Hospital Birmingham
2013: Freeman Hospital, Newcastle upon Tyne; Ipswich Hospital NHS Trust; University Hospital of North Staffordshire, Stoke on Trent; James Cook University Hospital, Middlesborough; Royal Cornwall Hospital, Truro; Salford Royal Hospital

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Unit 11, Lovett Road, Hampton Lovett Ind. Estate, Droitwich, Worcs, UK, WR9 0QG

Tel: +44 (0) 1905 774695 **Fax: +44 (0) 1905 796081**

web: www.nexusdms.co.uk **email: sales@nexusdms.co.uk**