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& Health Informatics*

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EUROPEAN SOCIETY
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THERAPEUTIC BEDS

*Based on a clinician-industry workshop
held in Amsterdam, 23-24 September 2005*

HEALTH TECHNOLOGY ASSESSMENT IN INTENSIVE CARE MEDICINE THERAPEUTIC BEDS

Based on a clinician-industry workshop held in Amsterdam, 23-24 September 2005

DELEGATES

CLINICIANS

Carl Waldmann, United Kingdom *Chair*
Michael Imhoff, Germany *Chair*

Jayne Fawcett, United Kingdom
David Goldhill, United Kingdom
Maximillian Jonas, United Kingdom
Barbara McLean, USA
Michelle Norrenberg, Belgium
David Ryan, United Kingdom
Neil Soni, United Kingdom
Chris Theaker, United Kingdom

INDUSTRY REPRESENTATIVES

Kate O'Dea, KCI Medical
Jochen Kaulitzky, KCI Medical
Matthew Clendining, KCI Medical
Kate Hancock, Hill-Rom
Bill Dunlevy, Hill-Rom

PROCEEDINGS EDITED BY

Michael Imhoff
Carl Waldmann
David Goldhill

PROCEEDINGS REPORTED BY

Chris Theaker

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INTRODUCTION

In 1996 The European Society of Intensive Care Medicine (ESICM) was restructured into a series of operational divisions including the Technology Assessment Section later to become the **Technology Assessment and Health Informatics (TAHI)** Section. This group has since grown significantly to include 235 members. One of the unique features of this group is the collaboration between clinicians and industry representatives. This clinical /industry interface is seen as a particular strength of this section.

This was the sixth combined industry and clinical workshop between members of TAHI and industry colleagues. The meeting was held under the auspices of ESICM and was chaired by Michael Imhoff (TAHI Research representative) and Carl Waldmann (TAHI Chairman).

The workshop was introduced and run as an open forum with explicit instructions to discuss principles rather than commercial dealings. As with previous workshops the topic **Therapeutic Beds** was chosen following a section debate at the TAHI Annual General Meeting the previous year.

Previous workshops

The first workshop in London, 1999 provided a springboard for debate on the current status of Health Technology Assessment, the second workshop in Rome in 2000 facilitated a discussion of Monitoring and the third workshop in Geneva in 2001 looked at Organ Support technologies. The following two workshops in Barcelona 2002 and Amsterdam 2003 focused on clinical issues of Health Informatics.

All the workshops have been supported by unrestricted educational grants from industry and the participants have been clinicians and practitioners in Intensive Care Medicine with representatives from industry. The workshop format encourages an opportunity for free and frank exchange of views. This facilitates an understanding between clinicians and colleagues from industry regarding perceived medical requirements and realistic technological and economic limitations. It also allows identification of regulatory and legal constraints and provides the opportunity to explore avenues for future collaboration and research.

These workshops have formed the basis of a set of principles for health technology assessment in Intensive Care Medicine and have contributed to the ESICM distance learning module (PACT) on Health technology assessment. The monographs resulting from these workshops are presented to the Council of the ESICM and disseminated to all members and other interested parties.

This monograph reports the proceedings of the Clinician-Industry Workshop held on Friday 23rd September and Saturday 24th September 2005 at the Okura Hotel prior to the Amsterdam Congress of the ESICM.

Dr Waldmann made the point during the workshop that the 'therapeutic bed was one of the least understood tools of the practitioner's trade'. An informal survey conducted between ESICM clinicians suggested that the majority of clinical personnel have a limited knowledge of therapeutic surfaces or specialty beds in comparison to other medical devices in the ICU. Therefore, one of the goals of this workshop was to achieve and communicate a better understanding of the clinical application of therapeutic intensive care beds. The technology associated with these beds has, until recently, been rarely discussed. Perhaps this is because bed technology is perceived as rather static when compared to organ support, monitoring, new drugs and information technology developments. It is hoped that this monograph will begin to address the paucity of information and lack of understanding about therapeutic surfaces as the platforms central to the care of critically ill patients.

As an aid to readers a glossary of definitions of bed frames and bed surfaces is attached as appendices I and II.

What are therapeutic beds/surfaces?

The word 'therapeutic' implies '*used to treat disease and help healing take place*'.

Beds are probably the most frequently used medical device for individual inpatient care. Although there are a number of hospital bed manufacturers in Europe and the United States, most of them produce beds for standard ward areas. Most clinicians have an intuitive understanding of what a bed is, but appear unclear as to what constitutes or defines a 'therapeutic bed'.

The beds on an intensive care unit are frequently thought of as passive devices offering little more than a surface on which to place patients. There has been a failure to recognise that beds are not only a platform on which intervention and treatments occur but they have original therapeutic potential and can enable and deliver a variety of therapies.

The use of the adjective 'therapeutic' with reference to beds can be misleading as it does not describe the bed's physical properties but is more related to what the bed can be used for and deliver. The definition of a 'therapeutic bed' would therefore encompass potential physiological effects and include psychological aspects. These therapeutic functions may be both prophylactic or interventional in nature.

The therapies which can be delivered by a bed are many and will continue to increase. The therapies include thermoregulation, pressure related wound care support including pressure re-distribution and moisture management, patient positioning techniques including continuous rotation, proning, semi recumbent positioning, turn assist options, physiotherapy techniques including, vibration and percussion, and patient comfort improvement. Beds may provide lateral rotational therapy and help to prevent pneumonia, or enable patients with acute respiratory distress syndrome (ARDS) to be placed in the prone position.

Therapeutic beds are complex, high technology devices that have undergone extensive development and are manufactured to high standards. Physicians however are often unaware of the complexities of newer critical care beds. Fortunately in many institutions the nursing staff has recognised the potential impact on patient care benefits and usually make the decision to use therapeutic beds. There is an extensive bibliography relating to skin and pressure care, and the use of pressure relieving devices and prevention of pressure ulcers/lesions has been the subject in the UK of a NICE report [30]. Many studies in the intensive care literature refer to the use of therapeutic beds for rotational therapy or proning in the prophylaxis and treatment of acute pulmonary diseases.

Standards for manufacture

Hospital Beds, including therapeutic surfaces, are designated a 'Medical Device' under the definition of the Medical Device Directive (MDD) 42/93/EEC. Application of the CE Mark (Conformite European) means that the product conforms to the essential requirements of this directive. A 'Competent Authority', usually part of the Ministry of Health or similar, is charged with monitoring compliance with the directive. The full directive can be viewed at www.europa.eu.int.

The manufacturer of the device (in this case a bed or sleep surface, or combination of the two) is responsible for establishing that the device is safe and that it is suitable for its intended purpose. The standards required to meet the essential requirements of the directive are dependent on the type of device, the intended purpose and the degree of risk attached thereto. Manufacturers are required to keep a technical file, which includes design history, analysis of risks that could arise during use, an assessment of relevant pre-clinical and clinical data, and the preparation of appropriate instructions for use in the relevant language.

Specific manufacturing standards are dependent on the type of device. In the case of electrically operated devices, or devices to be attached to another electrically operated device, IEC (International Electrotechnical Commission, www.iec.ch) standards, including those on electromagnetic compatibility, apply. The IEC also provides standards on alarms and labelling, ensuring ease of understanding and reducing trade barriers. There is a specific amendment to the standard related to electrical hospital beds IEC 60601-2-38.

A Notified Body is a certification organisation that has been designated by the Competent Authority to carry out the audits described in annexes of the directive. Each manufacturer will use a Notified Body to verify compliance to the MDD, and/or to audit the company's quality processes and procedures. One is entitled to ask the company for this information.

Materials used

The materials used in the manufacture of the product will be subject to other standards and safety requirements. For example, there are specific regulations regarding the composition of paint or other coatings. Fabrics will be required to be biocompatible and hypoallergenic and will also be required to comply with environmental standards regarding the use of toxic substances in addition to meeting Fire Retardancy requirements. High specification foam is preferred to ordinary hospital foam for the prevention and treatment of pressure ulcers/lesions. Dozens of different metals & plastics may be used in the manufacture of a hospital bed.

Maintenance

In some countries, therapeutic beds are available via a rental contract, in which case the manufacturer undertakes all preventative and necessary maintenance. Devices which are leased or purchased should also include a service agreement and maintenance should be undertaken at intervals recommended by the manufacturer.

Training and support

The majority of manufacturers will provide training sessions on the use of the device, particularly on initial placement or installation. Such training and the support levels available should be specified in the contract

Hazards of immobility

Hazards associated with patient immobility have been well documented and are associated with complications involving different organ systems [5, 8, 23]:

- ◆ Central nervous: distortion of balance and coordination
- ◆ Cardiovascular: reduction of stroke volume and cardiac output, deep vein thrombosis, hypotension
- ◆ Gastrointestinal: constipation, glucose intolerance
- ◆ Genitourinary: kidney stones, urinary tract infections, reduction of diuresis
- ◆ Musculoskeletal: muscle wasting, osteoporosis, pressure lesions
- ◆ Respiratory: atelectasis, pneumonia, alveolar derecruitment and extravascular lung volume

CLINICAL USE OF THERAPEUTIC BEDS

One Canadian study performed a snapshot audit of practice and found that on a specified day about 3% of all ICU patients were treated in rotational beds [13]. The panel discussed the indications for therapeutic beds and although spinal injuries and mobilisation needs were recognised as a frequent reason to use certain beds (spinal injuries are specifically contraindicated for some beds; see manufacturers literature), most indications in intensive care were either related to respiratory disease management via their ability to provide physiotherapy techniques (vibration and percussion) and continuous rotation, shifting the lung zones (dependent and independent), or the prevention and treatment of cutaneous pressure lesions by pressure re-distribution and relief of maceration. They may also have a role to play in rehabilitation by facilitating mobilisation.

The timing of initiation of therapeutic bed therapy was discussed. It was generally agreed that these beds are often used too late in an attempt to alter respiratory pathophysiology. However there is evidence building to support alteration of ventilation-perfusion matching and secretion clearance facilitated by features of therapeutic beds. Mechanisms enabling patient rotation and repositioning, pulsation/vibration/percussion and patient proning are recognised to have an impact. Unfortunately, the exact timing of patient positioning to alter outcome in respiratory disease and effects of different patient-bed interactions remains a subject for further discussion and research. Ultimately an evidence base is required to show the impact of these beds in the prevention and resolution of acute respiratory conditions such as ventilator associated pneumonia, atelectasis and ARDS.

The use of therapeutic beds for prophylaxis and treatment of pressure lesions is a frequently cited reason for their use. Pressure ulcers/lesions develop from a combination of internal and external factors. External terms such as 'shear', 'friction' and 'maceration' were felt to be useful. Therapeutic beds attenuate the development of ulcers/lesions by autonomous movement or by the use of specially designed cushions which redistribute pressure away from vulnerable areas of the skin to prevent tissue breakdown. Again it was unclear when, and at what stage a therapeutic bed should be used.

Indications

The literature detailing risks factors where therapeutic beds are utilised is referenced [2, 15, 17, 26, 27]¹. Indications include:

- ◆ Intubation and mechanical ventilation for more the 48 hours
- ◆ Immobility
- ◆ Sepsis
- ◆ ARDS
- ◆ Pneumonia
- ◆ Inability to tolerate manual turning (e.g. desaturation, haemodynamic instability)
- ◆ Smoke inhalation
- ◆ Paralysis or heavy sedation
- ◆ Obesity, body mass index (BMI) >30
- ◆ Inability of ICU staff to turn the patient every 2 hours
- ◆ Pressure ulcer/lesions
- ◆ Extended surgery
- ◆ Old age
- ◆ Lung abnormalities, decreased exercise tolerance
- ◆ General ease of nursing care

In clinical practice the specific therapeutic bed therapy is chosen according to whether the primary focus of the bed is for pulmonary management or for the management of pressure ulcers/lesions or a combination of both. These decisions are rarely made by physicians and it is usually nursing staff (especially tissue viability nurses) and physiotherapy staff who are involved. There are other factors which can influence the decision for type of therapy or when to start. They include local practice and preference, availability, price, the patient's clinical condition, total bed management systems and type of therapy required. Education, product knowledge and features are also factors.

Existing guidelines

The Center for Disease Control (CDC) and Healthcare Infection Control Practices Advisory Committee 2003 commented on turning or rotational therapy: '*No recommendation can be made for the routine use of turning or rotational therapy...*' (Unresolved issue). And on physiotherapy: '*No recommendation can be made about the routine use of chest physiotherapy on all postoperative patients at high risk for pneumonia.*' (Unresolved issue) [11].

Regarding prevention of pneumonia, Dodek et al stated [9]: '*On the basis of evidence from seven level 2 trials and one level 3 trials we conclude that the use of kinetic beds is associated with decreased incidence of VAP.*' There was agreement in the group that currently for most potential clinical indications for therapeutic beds there currently are no clear, unanimous guidelines.

¹ The indications, contraindications and precautions for specific beds will be found in the manufacturers' literature, and may differ from this list.

What is the evidence?

There is considerable ignorance about the evidence for and limitations of therapeutic beds. Most studies look at outcomes associated with either pressure ulcer/lesions prevention or resolution of respiratory conditions. Most outcomes were soft and much of the evidence is anecdotal. Moreover, patients in ICU receive multiple interventions and this makes it difficult to isolate the effect of therapeutic beds from other interventions. The number of variables in many of these studies makes it difficult to draw firm conclusions. Basic issues such as why and how patients should be turned have yet to be fully explored. Most studies use two hourly turning as a comparator, but evidence and experience suggest that in practice two hourly turning is not always performed. Thus far, all studies looking at respiratory outcomes have failed to show a difference in mortality. Several individual prospective randomised studies have demonstrated that rotational therapy prevents and treats respiratory complications [16]. Meta-analysis supports this conclusion [11]. There is no convincing data to show that therapy decreases either ICU or hospital stay. However, there is a lack of good quality studies demonstrating outcomes for both areas, respiratory and pressure ulcer/lesions.

Evidence does demonstrate that the use of protocols can lead to better patient outcomes [20]. There may therefore be a need to follow protocols when using therapeutic beds (see Appendix III). However, current protocols are anecdotal or expert recommendation only [11]. Some evidence demonstrates alternating pressure mattresses, low air loss therapy and fluidised beds are useful for prevention and treatment of pressure ulcers/lesions in locations outside the ICU. Automatic extrapolation of such data to ICU should be done cautiously however there have been small studies showing benefit in ICU patients [1, 18, 21].

The incidence of pressure ulcers/lesions in the critically ill has been suggested to be between 3-29% [3, 6, 7]. Other evidence exists which indicates that around 13-14% of patients will develop pressure ulcers/lesions whilst staying on ICU [14, 24]. The variation in incidence might be explained by the amount and level of exposure to certain risk factors. This area requires further examination although one study [25] has suggested that length of stay, faecal incontinence, APACHE II score, anaemia, albumin and prealbumin levels, and norepinephrine infusion are risk factors that are associated with pressure ulcer/lesion development. What is not clear from the evidence is whether the early use of a pressure relieving device would reduce the impact of intrinsic risk factors. The net result is that it is inherently difficult to identify with any degree of precision which patients are at risk for pressure sore development. It does not necessarily follow that there is an automatic requirement to allocate every ICU patient to a specialist bed. The decision to do so must be based on the features of the bed and the unique characteristics of each patient. The decision, once made, must then be put under constant review.

Contraindications, limitations of use and side effects

Clinical factors such as weight limits, accidental extubation, corneal ulceration, unstable intracranial pressure, motion sickness, dysrhythmias, agitation, comfort, etc. should all be considered when deciding to use a therapeutic device.

There are few, if any, absolute contraindications to rotational therapy. There may be contraindications or limitations to a specific device. One example may be that rotational therapy is indicated but the patient exceeds the weight limit of the initially chosen device or that they have an unstable spinal injury which is unsuitable for most devices. Moreover, there needs to be differentiation between absolute and relative contraindications. Absolute technical contraindications would be patient specific characteristics such as size or obesity, whereas severe agitation on turning or dysrhythmias may be considered relative contraindications that have to be considered against the potential benefit from using a therapeutic bed.

Typical side effects include motion sickness where hyoscine patches may help. Tracheal tube or catheter dislocation are potential complications of rotational therapy, but usually can be prevented by preparation and attention to detail. Haemodynamic instability is not an absolute contraindication to the use of a therapeutic bed, but needs to be taken into account when setting rotation parameters. Care should be taken to prevent corneal ulceration when using the prone position

COST EFFECTIVENESS OF THERAPEUTIC BEDS

There is limited work published on cost effectiveness [4, 10, 12, 28, 29]. The cost effectiveness of therapeutic beds on service provision on the ICU has to be carefully considered. Furthermore, it must be assessed whether (a) significant differences in business outcome, and (b) significant improvements in the cost of care can be achieved.

Cost benefit analysis in this area is difficult. Cost effectiveness should not only be viewed financially. Areas such as reduced workload, injury prevention for user and operator, nursing time and prevention of complications must also be considered. Also factors such as ergonomics and patient/user satisfaction should also feature in. This includes the prevention of staff injuries and, finally, the retention of qualified care providers.

It may be difficult to do a cost benefit/effectiveness analysis, as therapeutic beds do not always appear on ICU budget statements. Whether or not they do is largely dependent on regional or local practice and what data is available is dated.

Cost effectiveness analysis has demonstrated that two areas exist where cost savings can be made for users: 1) Outsource the management of beds i.e. lease them as opposing to buying them and 2) Instigating a bed protocol.

There are additionally three aspects that should also be considered in general:

- ◆ Treatment of most conditions, for instance pressure ulcers, is typically at least twice as expensive as prophylaxis. Pressure ulcer costs vary widely between studies as there is insufficient consistency in the study methodology [22].
- ◆ There are no methodologically good studies into the cost of therapeutic beds for pulmonary disease, especially not in comparison with other treatment modalities.
- ◆ Therapeutic beds represent only a very small fraction of the total cost of intensive care. In the UK out of a daily cost of about € 2300 per patient only about € 75-150 is spent on the cost of leasing a therapeutic bed².

For a business case the cost of the bed (purchase or lease) and the running cost (in case of purchase) need to be figured in, as well as the potential benefits, savings, etc.

These include:

- ◆ Medical effects
 - Better outcomes
 - Reduced length of stay
 - Reduced incidence of complications, e.g. prevention of one nosocomial broncho-pneumonia saves an additional average treatment cost of € 25 000.
- ◆ Nursing benefits
- ◆ Effect on staff injury, sick leave days. The cost to the NHS of manual handling accident-related sickness alone is € 600 million a year. Every employee who retires early because of a back injury costs the NHS at least an extra € 90 000 and compensation claims for manual handling accidents to staff are rising [31].

There is a continuing trend towards electric powered beds in all care areas particularly because of the risk of staff injury and workload/force issues.

² Prices will vary according to local contracts

THE FUTURE OF THERAPEUTIC BEDS

There are many trends in healthcare in general and intensive care in particular that influence the future development of therapeutic beds and their use in clinical practice:

- ◆ Increasing acuity in all care areas
- ◆ Increasing relative and absolute number of ICU beds
- ◆ Increasing use of continuous monitoring and therapy outside the ICU
- ◆ Increasing number of co-morbidities
- ◆ Increasing cost pressures
- ◆ Increasing staff shortages
- ◆ Outcomes based on health related quality of life

A specific and dramatic development is the increasing prevalence of obesity in the developed countries with a growing incidence of morbid obesity, and more patients undergoing bariatric surgery. These and other developments lead to clear challenges for the use of therapeutic beds in the future.

◆ **Obese patients becoming a greater concern**

Evidence was presented that indicated that the population is, on the whole, getting heavier. It will become increasingly important to consider the care requirements for bariatric patients in business cases in the near future.

◆ **Infection control issues**

The emergence of resistant organisms in the ICU is a major problem. Standards of cleanliness and methods of cleaning should ensure that therapeutic beds do not act as reservoirs for micro-organisms.

◆ **Transportation issues**

The more sophisticated the bed the heavier it is. This causes problems for nurses, anaesthetists and portering staff when transporting the patient either to or from the ICU. The issue is often compounded by the weight of the patient and associated equipment. Impromptu storage devices exist that can be added to a bed primarily for the transporting of associated equipment often makes one end of a bed heavier than another. It should be noted that some beds are not suitable for transport and it is not recommended. Impromptu storage devices may constitute an unauthorised modification and render the device unsafe. Responsibility for safe functioning of the device in the case of unauthorised modifications passes to the health care worker/hospital.

◆ **Technological advances**

There were suggestions that greater integration of the therapeutic beds and information technology was needed. This could facilitate better recording of weight, temperature, etc. As the bed is the centre of care delivery, ECG monitoring and respiratory rate could become future features of therapeutic beds subject to actual need. This extra modality could record for instance level of compliance with Head-up Tilt as part of the Ventilator Care Bundle.

Important note

Modifications made to medical devices (including beds) without the manufacturers specific authorisation, may render the device unsafe. The legal implication is that responsibility for the safety and performance of the device may move from the manufacturer to the hospital or health care professional [19].

Future therapies were discussed such as add-ons to normal beds, new therapeutic modalities in the areas of thermal management or organ system specific treatments, new prophylactic modalities as well as the combination of different therapeutic and/or prophylactic functions or automated therapy. The clear statement from the industry was that technology is rarely the limit for the development of new features in therapeutic beds. Most often the limiting factor is the cost of new technologies. New specific additional functionalities that may be seen in the future were discussed:

- ◆ Motion sensors
- ◆ Better accessibility for imaging including X-rays
- ◆ Mobilisation of patients, especially obese patients
- ◆ Extreme positioning, e.g. standing up
- ◆ Functionalities to reduce lifting related staff morbidity
- ◆ Transport issues
- ◆ Motorized beds
- ◆ Thermal management
- ◆ Monitoring related to beds
- ◆ Location technology
- ◆ New surface qualities, e.g. antimicrobial properties
- ◆ Disinfection and automated cleaning

Whether such functionalities will be seen in clinical practice depends on the technology pull from the medical community. In any case, it was emphasized that beds and their future development cannot be isolated, but needs to be viewed in the context of the entire continuum of care.

CONCLUSIONS

Beds are the most ubiquitous medical device in hospital care. Most beds are primarily used as a platform for physical support and to transfer the patient. Therapeutic beds offer functionality beyond this, and this additional functionality is intended to provide some tangible therapeutic benefit for the patient and/or some other benefit for the caregiver.

The use of and indication for therapeutic beds are usually left to the nursing staff, while most physicians are often unaware or show little interest in the clinical relevance of modern therapeutic beds and related technologies.

As there are many well known hazards and complications related to immobility, many indications for the use of therapeutic beds aim at the prevention or treatment of such problems. Another area of application is the prevention and treatment of acute or acute on chronic respiratory disease. There are many case reports and uncontrolled studies in the literature. There are about 20 randomised prospective studies examining the benefit of continuous rotation to treat and prevent respiratory complications. Although the design and quality of all of these studies can be criticised, the weight of evidence demonstrates that these beds can be beneficial when treating and preventing pneumonia, although there is no clear evidence that this decreases ICU or hospital stay or decreases mortality. This is an area where further coordinated clinical research is needed.

Still, it became apparent from the workshop discussions that the use of therapeutic beds is most effective in the context of therapeutic and nursing protocols. It was also undisputed that contraindications to and complications from the use of therapeutic beds are few. Contraindications and limitations of use can be related to a treatment modality in general, and thus be relevant irrespective of the specific bed make, or they can refer to the capability of a specific bed type or model (e.g. weight or size limits). Clinical decisions about contraindications and limitations of use required a good understanding of the features and functionalities of therapeutic beds.

The costs for therapeutic beds from purchase and maintenance or lease represent only a very small fraction of the total cost of a patient episode on the intensive care. There are also potential staff-related as well as non-medical benefits. These may include potential improvements in patient comfort, promotion of rest, reduction of stress better clinical outcomes, reduced incidence of complications, but also reduction of the risk of staff injury and better retention of nursing staff. These benefits may also translate into measurable financial savings. Unfortunately supportive economic data is not available and sufficiently powered studies are lacking. This is an important area where future coordinated research is needed.

Well controlled research is also needed, because it can be expected that therapeutic beds will be used more widely in intensive care and other inpatient care areas in the future. Trends in healthcare that will have a direct influence on the future development of therapeutic bed technology are the growing percentage of obese patients, infection control issues, increasing importance of intra- and interhospital transport. The realization of technological advances in bed products mostly depends on the technology pull from the medical consumer. Clinicians should become more active in the understanding and development of therapeutic beds, and participate in focus groups and research development groups, as the development of these technologies must be seen from the perspective of the entire continuum of care.

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APPENDIX I - BED FRAMES

TECHNICAL TERM	DEFINITION
Manual bed frame	A bed frame that is operated by manual means, either mechanical and/or hydraulic.
Electric bed frame	A bed frame which is operated by electrical motor(s).
Integrated side rails	Side rails are part of the bed frame construction and cannot be removed.
Manoeuvrability	Manoeuvrability of the bed frame is assisted by castor configurations and design; can be motorised.
Head elevation	The head section of the bed can be elevated to support patient in the seated position.
Knee gatch	The knee section of the bed 'bends' to prevent forward sliding. The knee gatch function may be automatic on head elevation and is usually found on electric bed frames.
Weigh scale	An electronic scale to weigh the bed contents (usually a patient) is integrated into the bed frame.
Weight limit/height limit	The upper limits of patient parameters that the manufacturer recommends. May refer to the weight bearing capacity of the bed frame, known as the 'safe working load', or the ability of the surface to provide support, and known as the 'therapeutic limit'.
Head up/down tilt	The head of the bed may be lowered or raised on a single plane. Sometimes erroneously referred to as 'Trendelenburg' and reverse Trendelenburg'.
Integrated surface	The mattress or sleep surface is integral to the bed frame and cannot be exchanged for a different type of surface.
Removable head/foot	The foot board and head board can be removed from the bed frame.
Expandable length	The foot of the bed can be expanded to accommodate unusually tall patients. May be manually or electrically operated.
Cardiac chair	A position in which the backrest is elevated to approximately 40°, the knee gatch is engaged and the feet end dropped to assume a chair position to aid the work of breathing.
Side to side tilt	The bed tilts along its longitudinal axis usually up to 30°. The tilt is not a continuous motion.
Kinetic therapy	Kinetic therapy™ is a trade mark of KCI and refers to continuous lateral rotation of a patient side to side to a measurable angle. Is sometimes used generically as an alternative to CLRT (see below).
Continuous lateral rotation therapy (CLRT)	The continuous programmable rotation of a patient from side to side, often shortened to CLRT. Is sometimes used generically as an alternative to Kinetic therapy™ (see above).
Pause time	The time which the bed remains in either the central, left later or right lateral position during rotation. Usually programmable.
Patient controls	Bed controls that may be activated by the patient, either on inside of side rails or contained within a separate device. Usually lockable.
Upright Chair or FullChair®	The bed configures into a chair-like position with the head elevated and the feet lowered. FullChair® is a trademark of Hill-Rom Inc.

APPENDIX II - BED SURFACES

TECHNICAL TERM	DEFINITION
Foam mattress (including types of)	Polyurethane: of various densities. (Density = weight per cubic metre) Visco-elastic: a type of foam which responds to body warmth & conforms to shape. Either of the above types of foam may be plain or cut in a variety of configurations to maximise weight distribution. Foam mattresses will also contain fire retardant agents and anti-microbials.
Air-filled sacs	Cushions or tubes of waterproof material which are filled with air to provide a conformable surface.
Low air loss	Air is supplied constantly to the cushions (rather than a single inflation) by a blower. Air escapes from the cushions via seams or air permeable fabric. The surface is therefore more conformable providing a cool dry interface.
Mattress replacement system	The basic (usually foam) mattress is removed and the system is placed on the bed frame. May or may not be electrically operated.
Mattress overlay	The system is placed on top of the existing (usually foam) mattress. May or may not be electrically operated.
Moisture management	Insensible losses create moisture, which particularly in association with raised surface temperatures can result in skin breakdown. Some systems allow for the evaporation of this moisture by the use of special fabrics and air flow.
Pressure relieving	EPUAP (European Pressure Ulcer Advisory Panel) 'Pressure Ulcer Treatment Guidelines' state: <i>There is no agreed definition of the terms of pressure: relief - reduction - redistribution.</i> However this term is sometimes used in literature to describe alternating pressure / Continuous Low Pressure / Low Air Loss or Air Fluidised Devices.
Pressure reducing	As above, but sometimes used to describe static non powered systems or foams.
Shearing force	The process of two or more surfaces being pulled in opposite directions – i.e. skeletal structures and skin/subcutaneous tissue. Shear injury results from the opposing forces causing tears to underlying muscle.
Friction force	The rubbing of one surface against another causing a heat source. Friction strips the epidermis and can produce shallow superficial abrasions that may be painful and leave the skin at risk of conversion to full thickness damage or infection.
Pulsation	Small pockets of air are sequentially inflated and deflated to create a massaging wave from foot to head.
Bed warmer	Raises airflow above ambient air temperature.
Nurse Assist /Turn Assist	Turns the patient to either left or right side by the use of air cushions. Used to facilitate nursing care.
Air fluidised	Warmed air blown through silicon coated micro-spheres create a dry 'fluid' medium which supports the body.
Gel pads	Semi liquid gel enclosed in plastic covering.
Alternating pressure support	Mattress consists of a number of sealed air inflated cells that alternately deflate and inflate. Inflated cells are firm enough to support the body; deflated cells relieve or reduce pressure.

APPENDIX III - SUGGESTED PROTOCOL FOR THE USE OF THERAPEUTIC BEDS TO PREVENT AND TREAT RESPIRATORY COMPLICATIONS

PROPHYLAXIS

Conditions associated with atelectasis

- ◆ Surgery – abdominal aortic aneurysm repair, thoracic or upper gastrointestinal
 - ◆ Long operations (>2.5 hours)
 - ◆ Old age
 - ◆ Lung abnormalities
 - ◆ Decreased exercise tolerance
 - ◆ Heavy smoker
 - ◆ Obesity, BMI >30
-

Other indications

- ◆ Likely to be intubated and ventilated for >48 hours
 - ◆ Immobile
 - ◆ Sepsis
 - ◆ Paralysis or heavy sedation
 - ◆ Unable to tolerate manual turning
 - ◆ Desaturating and haemodynamically unstable
 - ◆ Staff unable to turn 2 hourly
-

TREATMENT

PaO₂/FiO₂ <30 kPa (225 mmHg equivalent to PaO₂ of 12 kPa with FiO₂ of 0.4)
Infiltrates, pneumonia, ARDS, atelectasis, sputum

AND/OR

High-risk patient factors

CONTRAINDICATIONS

- ◆ Severe agitation on turning
 - ◆ Dysrhythmias on turning
 - ◆ Beyond weight and height limits of equipment
-

BED TYPE

Consider platform bed (e.g. RotoRest) if

- ◆ Spine unstable
 - ◆ Pelvic trauma
 - ◆ Severe head injury
 - ◆ Flail chest
 - ◆ Skeletal traction
-

Initiation of treatment

- ◆ Prophylaxis: within 24 hr of ICU admission
 - ◆ Treatment: within 24 hr of intubation or respiratory complications
 - ◆ Check and record skin integrity
 - ◆ Ensure safe transfer to bed
 - ◆ Position patient: attention to head and body alignment, head up 30 degrees
 - ◆ Secure all tubing and lines to allow for rotation
 - ◆ Safety features in place such as supports, belts, side-rails
 - ◆ Start rotation
 - ◆ Consider customer support from bed supply company
-

ROTATION PARAMETERS

- ◆ Acclimatisation: start at >25 degrees increase hourly
 - ◆ Duration: >18 hours/day
 - ◆ Angle of rotation: >30 degrees (preferably >40 degrees)
 - ◆ Pattern of rotation: pause when supine and at extremes
 - ◆ Consider adjuncts: percussion/vibration/pulsation
 - ◆ Contraindications include flail chest, bronchospasm, rib fractures
-

ASSESSMENTS

- ◆ Response to therapy
 - ◆ Duration and angle of rotation
 - ◆ Complications
 - ◆ Transient desaturation, haemodynamic changes, lines & monitors
 - ◆ Need for bed
 - ◆ Skin integrity
-

DISCONTINUATION

- ◆ Improving respiratory function
- ◆ Patient mobile
- ◆ Patient coughing
- ◆ Haemodynamically stable with manual turning
- ◆ Rotation <18 hrs/day



European Society of Intensive Care Medicine

Avenue Joseph Wybran 40

B-1070 Brussels, Belgium

Tel 32 2 559 03 56

Fax 32 2 527 00 62

E-mail public@esicm.org

Internet <http://www.esicm.org>

