

# Strikethrough Resistant Technology™: a possible solution to mattress audit failures

## KEY WORDS

- ▶ Fluid ingress
- ▶ Infection prevention
- ▶ Mattress failure
- ▶ Risk management
- ▶ Strikethrough

In response to problems with spontaneous fluid ingress (striekthrough) in pressure-reducing support surfaces, NHS Greater Glasgow and Clyde has worked alongside industry, testing a new mattress cover material. Since January 2012, mattresses supplied with Invacare's Strikethrough Resistant Technology™ (SRT) fabric have been in constant, heavy use throughout the hospitals. These products are regularly audited. Compared to the national average failure rate of 27%, the audit results revealed an annual replacement rate of approximately 1.9% for Crib 5 and 0.7% for Crib 7 covers. Failure was due to rips and tears rather than the small-scale damage traditionally associated with mattress striekthrough. There have been no reported product failures due to striekthrough. One SRT Crib 5 and one SRT Crib 7 cover were randomly selected and sent for testing at Dartex Coatings Quality Assurance laboratories after 3 years. Results across key performance indicators show the products still performed as well as the day they left the factory.

Pressure ulcer prevention and infection prevention are two of the major issues facing modern healthcare providers. The government has placed these avoidable harms at the forefront of various initiatives and incentive schemes (Belton et al, 2013; NHS Institute for Innovation and Improvement, 2014). In pressure ulcer and infection prevention, the reliability and effectiveness of a foam mattress and cover are of primary importance to the patient, clinician and equipment management organisation, be it at trust level or across an entire health board (NICE, 2014; Fletcher et al, 2015). Despite recent initiatives, many covers are not optimally protecting mattresses. This paper analyses the performance of a new mattress cover material using Invacare's Strikethrough Resistant Technology™ (SRT).

## PREVENTING PRESSURE ULCERS

There is currently a very strong emphasis on the collection and correlation of pressure ulcer prevalence and incidence, with the aim of reducing preventable pressure ulceration by up to 95% (Guy, 2012). Since July 2012, all NHS organisations have been expected to collect data relating to harm, including pressure ulcer prevalence (Guy, 2012), and

to implement strategies designed to eliminate them.

In the SSKIN bundle (Belton et al 2013; *Box 1*) adopted by many healthcare organisations as a clinical assessment tool, the first 'S' refers to 'surface', in recognition of the importance of the mattress and cover upon which the vulnerable patient is placed. Support surfaces are defined as 'specialised' devices for pressure redistribution, designed for the management of tissue loads, microclimate and/or other therapeutic functions (National Pressure Ulcer Advisory Panel [NPUAP], 2014). Pressure-reducing support surfaces are one of the most important, if not the key, nursing interventions available to tissue viability specialists (McFarlane and Sayer, 2006). A patient at risk of pressure ulceration must be nursed on a high-specification foam mattress (European Pressure Ulcer Advisory Panel [EPUAP], 2014). A mattress with a compromised cover provides suboptimal pressure area care, due to changes to the mattress core occurring following fluid contact.

## PREVENTING INFECTION

Over the past decade, the focus of much debate and activity has been around the prevention of infection. The long-term impact of this focus

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**Box 1. The elements of the SSKIN bundle (nhs.stopthepressure.co.uk, 2015)**

- ▶▶ Support surface requirements
- ▶▶ Skin inspection
- ▶▶ Keep patients moving
- ▶▶ Incontinence/moisture management
- ▶▶ Nutrition and hydration assessment

has been an increasing awareness of the possible causes of infectious disease, including the support surface. A damaged, compromised mattress cover leads to a contaminated core, and is a major vector in the spread of healthcare-acquired infection (Callaghan, 2013).

In targeting methicillin-resistant *Staphylococcus aureus*, *Escherichia coli* and *Clostridium difficile*, the infection prevention teams have included increased cleaning and introduced more thorough inspection of mattresses (British Healthcare Trades Association (BHTA), 2011). As part of this major review, the cleaning of equipment, protocols concerning auditing and replacement programmes in clinical areas were reviewed and updated. Since 2008, a more stringent, checking and cleaning regime has been established to ensure that all mattress products are free from risk and

fit for purpose (Stewart, 2010). Equipment that was audited every 6 months to a year is now often inspected upon the discharge of each patient or once per week (depending on local protocols). Advanced cleaning solutions are now used, which while effectively removing pathogens can also degrade the mattress cover material. The UK has high bed occupancy levels (90%), and therefore the frequency at which equipment is cleaned and disinfected is high.

**CONSEQUENCES OF MATTRESS FAILURE**

According to industry bodies, the reported increase in mattress failures in UK hospitals over the past decade “appears to have coincided with an increase in inspection rates, more frequent cleaning and disinfection of mattresses” (BHTA, 2011). The consequences of mattress failure are considerable, consuming staff time and putting a strain on financial resources (Figure 1). The practical process of claiming compensation or replacing items that are under warranty generates challenges at ward level. It disrupts care and puts staff and patients at risk. This problem was highlighted by a Medical and Healthcare products Regulatory Agency (MHRA) report (MHRA, 2010). Such has been

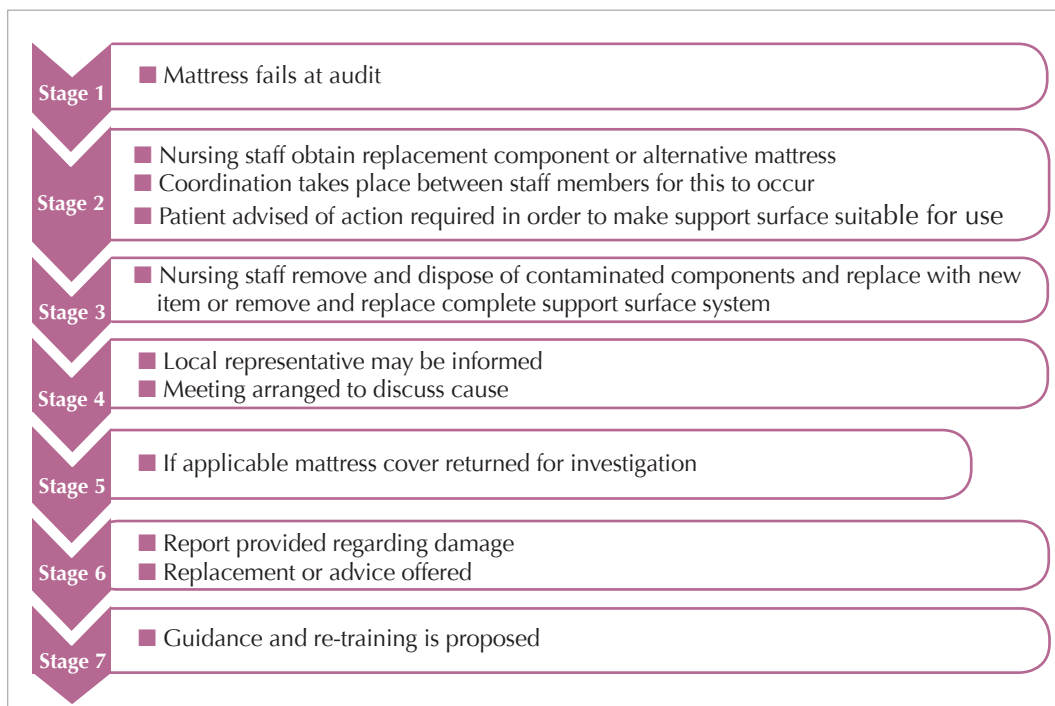


Figure 1. The consequences of mattress failure (from Invacare’s experience).



Figure 2. An example of a mattress with strikethrough.

the size and scope of the problem that it came to the attention of senior procurement and clinical managers (Stewart, 2010). In response, UK industry produced and promoted a guide for the care, cleaning and inspection of healthcare mattresses (BHTA, 2011). The aims of this report were supported by equipment manufacturers.

During this period, procurement departments believed that by purchasing new mattresses these replacement programmes would furnish the NHS with equipment expected to last for up to 7 years, in alignment with the manufacturers warranty; however, this proved not to be the case. The replacement products began to fail at a rate well above the national average failure rate of 27% (Stevens, 2013). This was specifically identified as being a result of fluid ingress (strike-through, see *Figure 2*), and was mirrored across the aforementioned organisations. In one instance, in the Western Infirmary, Glasgow the failure rate was approximately 100% within 9 months of issue, virtually all by fluid ingress. Some of the early failures were replaced under warranty, however these subsequently failed (Stewart, 2010). No sign of traumatic damage (scoring, tearing or puncture) was noted but microscopic faults in the coating were observed. Subsequent analysis showed these covers to be porous when subjected to water pressure through hydrostatic head testing (BS 3424: part 6). NHS Greater Glasgow projected a total yearly replacement requirement for every mattress.

Regardless of the technical reasons for the failures, be it cleaning, wear and tear or changes in cleaning/management protocols, the products were clearly no longer fit for the challenges of the environment.

## IMPROVING MATTRESS COVERS

### Performance requirements

Increased moisture leads to skin maceration, which increases the rate of tissue breakdown, contributes to the development of moisture lesions

and increases the risk of pressure ulceration. The new materials must therefore allow for moisture vapour transfer to achieve this balance; too little moisture will desiccate the wound, and too much will lead to maceration of the wound bed and surrounding tissue (Schultz et al, 2003). Skin that is too wet is up to five times more likely to ulcerate, and skin that is too dry is 2.5 times more likely to ulcerate than normal skin (Stevens, 2010). Closely associated with this is the need for the materials to be flexible/extendible enough to allow pressure redistribution through immersion and envelopment of the body. Incorrect cover material choice will increase the risk of friction and shear, two well-recognised factors in pressure ulceration damage (Ovens, 2012); thus the clinically-effective materials must be fire retardant, vapour permeable and multi-stretch as well as strong enough to cope with modern nursing environments.

### The science behind SRT

Invacare, working in strategic partnership with healthcare professionals and together with polyurethane coating specialists Dartex Coatings Ltd, developed the new highly durable SRT fabric, which was specifically created as part of Dartex Coating's Endurance fabric range. Invacare personnel have extensive experience developing pressure-reducing support surfaces, being regarded as the pioneers of castellated foam support surfaces. Dartex Coatings specialises in medical material manufacturing.

The SRT fabric uses an innovative textile coating that has been specifically designed to offer the highest chemical resistance possible without compromising on other essential characteristics, such as retaining breathability and stretch. The layered polyurethane swells less when exposed to moisture, ensuring reduced surface friction after cleaning and therefore a reduced likelihood of snagging or surface damage from transfer aids and other items.

The mattress fabric has undergone extensive evaluation in both laboratory and clinical settings, which includes a number of large acute hospitals with high patient turnover (Stevens, 2013). SRT covers ensure crucial levels of moisture vapour permeability at the patient interface, while maintaining exceptional

polyurethane abrasion and chemical resistance performance (Milnes, 2013). This means that in the process of cleaning the polymer surface the material changes less and soon returns to its initial condition. Thus the time when it is more prone to physical damage, as outlined in the BHTA document *Protect, Rinse and Dry*, is significantly reduced (BHTA, 2011).

The cover design improves infection prevention, and is available in Crib 5 (medium hazard) and Crib 7 (high hazard) fire-retardant material (BS7175: 1989). Compared to Crib 5 and other covers on the market, the Crib 7 cover is a significant advance in safety and durability while maintaining the required flexibility and breathability (Milnes, 2013).

**Performance after 6 months**

NHS Greater Glasgow and Clyde has been working in conjunction with Invacare in trialling the new cover material. Since January of 2012, 200 of Invacare’s SRT (Dartex Endurance) mattress covers, have been in constant, heavy use in acute wards and clinical areas throughout the health board.

The trial was across seven different wards: two wards in Stobhill Hospital and five wards in Southern General Hospital. The results from the first 6 months of use were analysed and published (Stevens, 2013). No spontaneous strikethrough was recorded and the clinical performance was comparable. Although an improvement on previous covers, more time was required to test the claims made by the manufacturer so in June 2015 Invacare commissioned an audit on the performance of the equipment after it had been in use for 3 years.

**OBJECTIVES**

The objectives of the 3-year audit of the SRT covers were to replace previously failed stock at Stobhill and Southern General Hospitals, to determine whether the new covers were an improvement to the previous products, which had been rigorously tried and tested, and to prove that the new covers were robust and practical in terms of:

- ▶ Increasingly high patient turnover
- ▶ Being more resistant to harsh chemical cleaning agents

**Table 1. Mattresses replaced after 3 years of use and reason for replacement**

Mattress covered in SRT material	Number audited	Replacement rate	% replaced due to physical damage	% replaced due to strikethrough
SRT Crib 5	71*	1.9	1.9	0
SRT Crib 7	48	0.7	0.7	0

\* 71 mattresses were audited — more mattresses were in use but were not available for audit on the day — no subsequent failures have been reported

- ▶▶ Withstanding vigorous regular cleaning regimes
- ▶▶ Providing an effective barrier to fluid ingress.

Meeting these objectives would free up nurse management time and resources, improve patient outcomes, and have a direct impact on procurement budgets.

Cover failure was measured as replacement due to strikethrough, which is the ingress of fluid with no apparent cause (i.e. sweat, urine, blood or faeces) breaching the inner aspect of the cover and as a consequence contaminating the foam, or replacement due to physical damage.

**RESULTS**

**Use on the wards**

Across the seven wards, no mattresses covered with the SRT material were condemned due to the original problem of strikethrough (0% failure rate), see *Table 1*. This confirms and reinforces the findings of the 6-month study (Stevens, 2013). The SRT-covered Crib 5 mattress had an average annual failure rate of 1.9% due to product damage and the SRT-covered Crib 7 mattress had an even lower rate of replacement, at 0.7% per year. These replacement rates compare favourably to the national average annual mattress failure rate of 27% (Stephens, 2013).

These results have major positive implications for management and staff at ward level. Not all mattresses were available for audit on the day, but no warranty claims have been made via procurement for any of these products.

**Mattress SRT cover testing at Dartex’s laboratories**

In July 2015, one cover from Ward 55, Southern General and one from Ward B, Stobhill Hospital were removed from mattresses in situ on the wards and replaced with new covers. The covers that

Table 2. Results of laboratory tests on the used mattress cover materials

Property	Test method	Crib 5 SRT	Crib 7 SRT
Weight	EN ISO 2286-2	No change	No change
Thickness	EN ISO 2286-3	No change	No change
Hydrostatic head	BS 3424-26	No change	No change
Coating adhesion	EN ISO 2411	Well in excess of specification	Well in excess of specification
Breaking strength	EN ISO 1421	Within typical range	Within typical range
Breaking extension	EN ISO 1421	Within typical range	Within typical range
Tear strength	EN ISO 4674-1	Within typical range	Within typical range
Moisture vapour transfer rate	BS 3424-34	Unchanged	Unchanged

had been removed were then sent back to Dartex Coatings for testing and comparison against their original production batch test results.

As part of the Dartex quality assurance process, each newly manufactured batch fabric undergoes a number of technical tests in a laboratory environment. This ensures that the product is consistently manufactured to both Invacare’s and Dartex’s high specified standard. A sample of each original batch material is then kept on file at Dartex Coatings. The tests examined the used covers against the original batch files in the following areas: chemical damage, changes to the moisture vapour transfer rate, peel strength changes and any damage to the cover surface due to abrasion and/or moisture exposure due to continual contact with cleaning materials (see *Table 2*).

The results of the tests show that the fabrics met, and in fact exceeded, the specified requirements, and there was no deterioration seen in any of the properties examined. The covers weighed the same as when they were originally produced, which is as expected if there is no coating loss. There was no reduction in the covers’ resistance to water penetration. The tear strength, breaking strength and breaking extension remained within the typical ranges of the material when it was first produced (before it had been used) and the moisture vapour transfer rate remained unchanged, indicating that the polymer has not significantly deteriorated following use.

On visual inspection, there was no change in shade, no sign of visible damage or staining

compared to the quality assurance sample. The used samples were slightly glossier, which is to be expected after 3.5 years of patient movement over a sheet, effectively polishing the surface. No coating damage was visible when the whole cover was examined while backlit. The samples were also examined under a microscope at 220× magnification and no changes were seen.

The results show that following over 3 years of continued use in a high turnover acute hospital environment, in which the mattress covers were subjected to regular cleaning with chemical agents, there was no evidence of abrasion or chemical damage. In fact, after 3 years in service, the SRT fabrics were ‘as good as when they left the Dartex factory’.

**Cost-effectiveness**

The cost of cover failure (mattress and cover replacement) was calculated at the standard failure rate of 27% using the NHS mattress list price. It must be noted, however, that at the height of the problem the failure rate was far higher, at over 100% per annum in some units (Stewart, 2010). *Figure 3* provides an illustration of the annual savings that could be made with the use of SRT Crib 5 and 7 versus a standard fabric. The figures are based on a typical 500-bed hospital over a 3-year period.

**DISCUSSION**

As a consequence of the results from the wards and the findings at the Dartex laboratory, it can be concluded that the long-term performance of SRT (Dartex Endurance) is significantly more effective than the mattress covers previously used within these high-turnover acute hospital environments.

When a mattress is inspected and a stain is noted, various actions are required to ensure that the patient has a replacement surface that is fit for purpose and poses no risk to his or her health. The time taken to action the return of a mattress, remove the cover, report the problem and provide feedback is lengthy and can involve several members of staff. This takes up valuable nursing time and can have a negative effect on patient anxiety levels. A significant reduction in failure, as seen with the audit of SRT products in Stobhill Hospital and Southern General Hospital, offers the following benefits:



- » A reduction in the time spent obtaining replacement equipment
- » Reduced moving and handling requirements
- » Reduced risk of physical damage to the patient due to transfer between mattresses
- » A reduction in patient concern
- » Reduced risk of healthcare-acquired infection
- » Budgetary savings
- » Improved fire safety (SRT Crib 7)

Invacare SRT fabric, covering both Crib 5 and Crib 7 mattresses, is a cost-effective solution to mattress failures. Combining its proven performance with “no negative clinical impact”, Stephen McDowall-Laing reported that the mattresses with SRT covers “continued to perform as expected for mattresses in general use in a busy stroke unit”. SRT fabric is offered on a range of Invacare products including Softform® Premier, Softform® Premier Visco, Softform® Premier Maxiglide and Softform® Premier Active 2 Hybrid mattress.

**CONCLUSION**

In this audit, Crib 5 and 7 mattresses covered with SRT fabric had a significantly lower failure rate than the mattress covers previously used by NHS Greater Glasgow and Clyde. Laboratory test results demonstrated that the covers were still effective and their properties comparable to

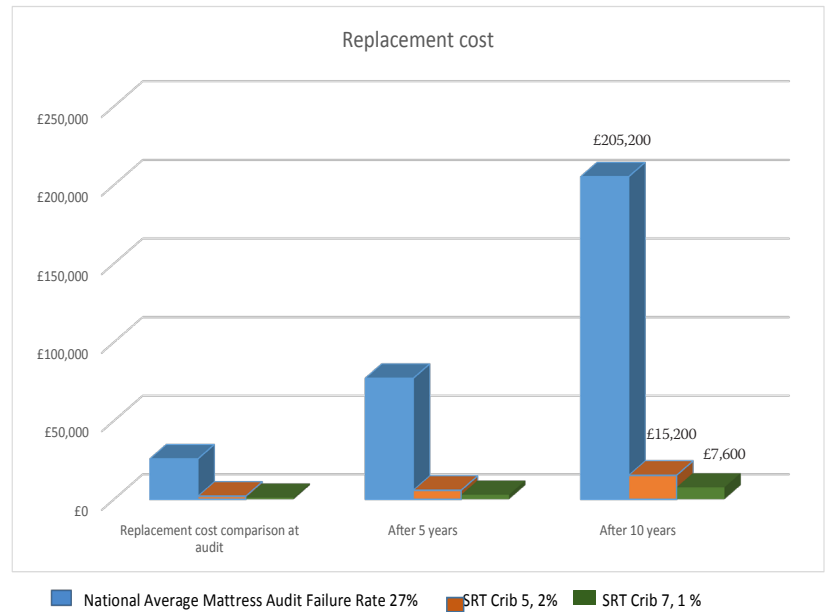


Figure 3: Comparison of mattress replacement costs for a 500-bed hospital based on failure percentages from audits as recorded at NHS Great Glasgow and Clyde (Jan 2015).

the quality assurance sample after over 3 years of heavy use. SRT fabric has demonstrated an ability to withstand the challenges of the healthcare environment, significantly reducing the problems associated with mattress cover failure.



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