Pressure redistribution in the ambulance: is this possible?

KEY WORDS

- Ambulance service
- Paramedic
- Pressure redistribution
- Pressure ulcers
- Risk assessment
- Wound care

In the UK, NHS ambulance services respond to 999 emergency calls for patients who have fallen and are unable to get up unaided. The mean ambulance response time for Category 3 calls has been identified as 90 minutes from call to attendance (Nuffield Trust, 2020). Therefore, in some cases fall patients can remain on hard surfaces for long periods of time, which can put a patient already at high-risk for developing a pressure ulcer (PU) at an even higher risk. A standard ambulance trolley mattress is constructed of inner foam and a tough outer material able to withstand constant cleaning and it must be stable and suitable for cardiopulmonary resuscitation while the ambulance is stationary or on the move. The standard ambulance trolley mattress is less than ideal for the use with patients at risk of PUs who are being transported to hospital. This review explores the potential benefits of using an alternative pressure redistributing support surface on a standard ambulance service trolley.

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It has been predicted that around 30% of the UK population aged 65 and over will fall at least once a year and for those aged 80 and over it is predicted to be as high as 50%, as stated in a Falls and fracture consensus statement published by Public Health England (PHE) in 2017 (PHE,2017. pp.6). UK NHS ambulance services respond to 999 emergency calls for patients who have fallen and are unable to get up unaided. As discussed by Schroder and Downie (2021), most fall calls to the ambulance service are classed as a Category 3 response, meaning they are classified as urgent but not life threatening. The mean ambulance response time for Category 3 calls was identified as 90 minutes from call to attendance (Nuffield Trust, 2020). Therefore, in some cases, fall patients can remain on hard surfaces for long periods of time, which can put a patient who is already at risk of developing pressure ulcers (PUs) at an even higher risk. It is difficult to find a definition of a what is a long lie time in the literature, however, an American study carried out to determine the prevalence of lying on the floor or ground in patients suffering with multiple sclerosis defined a long lie in their study as >1 hour (Bisson et al, 2015). If the patient is subsequently taken to hospital following a fall, they are transported in an ambulance on a standard trolley mattress. A standard ambulance trolley mattress is constructed of inner foam and a tough outer material able to withstand constant cleaning and has several sections in order that it can fold to conform to the various patient positioning options. It must also be stable and suitable for cardiopulmonary resuscitation while the ambulance is stationary or in transit. It is also important to recognise that the movement of the vehicle itself will cause movement of the patient on the ambulance trolley, increasing the risk of the patient being subjected to shear and friction forces from this movement (Gefen et al, 2020).

Myers (2008) defines a PU as a localised area of tissue damage that develops when soft tissue is compressed between a hard surface and a bony prominence. PUs can vary in depth and severity and can affect the epidermis, fascia, muscle, joint capsule or bone and are commonly seen over the sacrum, ischial tuberosity, trochanter and calcaneus, but can develop over many other areas with bony prominences. PUs can present as an open ulcer or with intact skin (Wood et al, 2019).

Tissue deformation from sustained body weight can lead to damage of the cell wall and cytoskeleton leading to plasma membrane poration and increased plasma membrane permeability (Gefen, 2018), which in turn can lead to deep tissue injury for the patient. The resulting abnormal transport patterns across the plasma membrane can then lead to loss of homeostasis causing apoptotic cell death. This can trigger inflammatory oedema increasing interstitial pressure in the tissue regions between bones and the supporting surface (Gefen, 2018). This localised oedema increases cell distortion further and over several hours ischaemic damage may build up, increasing the overall rate and extent of the tissue damage (Gefen, 2018). Therefore, patients who sustain a fall, and as a result have a long lie, which can be up to 90 minutes before the ambulance arrives at the scene, will be put at risk of deep tissue injury development as a result of cell/tissue deformation.

In practice, when attending patients who have fallen at home, it is found that they have often attempted to move or prop themselves up into a semi-sitting position, and this in itself can increase their potential for skin damage from pressure, shear and frictional forces. If the patient is incontinent of urine or faeces while on the floor the risk of skin breakdown is further increased. Persistent moisture can alter the resiliency of the epidermis to external forces by weakening the lipid layer of the stratum corneum and collagen (Moncrieff et al, 2015). Friction injury to the epidermis can occur when shear forces are present. In practice, this type of skin injury is possible when inadequate manual handling of patients occurs, especially if they have vulnerable skin integrity. To help prevent damage to vulnerable skin, UK ambulance service staff have manual handling training. In addition, they have at their disposal a range of moving and handling equipment such as: pneumatic air cushion lifting devices; banana boards; rotundas; slide sheets; and slide boards. Sophisticated electric wheelchairs with tank-like tracks to go up and down stairs are used along with state of the art electric powered lifting trolley beds. In contrast to this sophisticated equipment, the mattress used on the ambulance trolley is focused on support and durability and not pressure redistributing. As discussed earlier, the mattress has to be suitable for cardiopulmonary resuscitation on the move, support the patient from falling off the trolley and has to be durable enough to withstand cleaning between each patient and or body fluid spillage. The mattress is fixed securely to the frame of the trolley and is not easily removed. Currently in the East of England ambulance service there are two types of trolleys in use, namely Ferno Pegasus and Stryker Power-Pro XT. The Ferno Pegasus user manual states that this mattress has pressure relieving properties; however, all that is listed re this mattress in the user manual is that it is constructed of moulded cellular foam (Ferno UK Limited, 2007). The Stryker Power–Pro XT mattress has embossed onto its covering the manufacturers product information stating that it is constructed with polyurethane foam (Stryker USA, 2018); no mattress information is found in the user manual for this product. Neither mattresses have specific pressure redistributing properties. The European Pressure Ulcer Advisory Panel (EPUAP), National Pressure Injury Advisory Panel (NPIAP) and Pan Pacific Pressure Injury Alliance (PPPIA) (EPUAP et al, 2019) all recommend that "for individuals with, or at risk of a pressure injury, consider using a pressure redistributing support surface during transport," but also recommend "using a high specification reactive single layer foam mattress or overlay with high specification qualities, to consider using a reactive air mattress or overlay and to assess the relative benefits of using an alternating pressure air mattress or overlay or medical grade sheepskin for individual at risk of pressure injuries". Despite this recommendation, specific pressure redistributing support surfaces are not routinely used with the ambulance trolley mattress. In an observational, cross-sectional descriptive study, participants (n=212) were recruited when presenting to the emergency departments (ED) of two Australian tertiary hospitals to identify the prevalence of PUs in adults presenting to the ED by ambulance (Fulbrook et al, 2019). This small study concluded that PUs were identified in 11/212 participants, giving a prevalence of 5.2% at presentation to the ED. The researchers concluded that PU surveillance and risk assessment should commence at the point of presentation to the ED, facilitating early prevention/treatment strategies. Fulbrook, Miles and Coyer (2019) go on to recommend that pressure-relieving devices should be considered for use in the ambulance for those at greatest risk of PU development. They do, however, acknowledge that this could be problematic to introduce in practice. A UK pilot study carried out within the ambulance service with the aim of improving the identification of patients at risk of PUs, when attended by ambulance staff, in their own home or in the nursing/residential home settings found 67/127 (53%) of the participants had an existing PU (Mains et al 2020). They concluded that the identification of PU at risk patients by ambulance staff is essential, but must run alongside education for the ambulance staff and that they should have access to pressure reduction equipment for use within the ambulance (Mains et al, 2020).

This review seeks to explore the potential benefits of using an alternative pressure redistributing support surface on a standard ambulance service trolley, with the aim that this may aid patient comfort and have the potential to minimise the forces of pressure, shear and friction during the patient's journey to hospital. Presently this is an area where there is a dearth of literature. It is hoped that by raising the profile for the need of pressure redistributing support surfaces specifically for ambulance trolley use it will encourage the development of these type of products.

Pressure redistributing support surfaces that could be considered for use in an ambulance

In the absence of specific evidence around the effectiveness of pressure redistributing support surfaces in reducing PUs in an ambulance setting, it is necessary, therefore, to look at the evidence for this from other healthcare settings. Nixon et al (2006) conducted a randomised control trial (RCT) (n=1972) in 11 UK hospitals that compared whether differences existed between alternating pressure overlays (APOs) (n=990) and alternating pressure mattresses (APMs) (n=982) in the development of new PUs, the healing of existing PUs and patient acceptability. They concluded that no statistically significant differences were found between APMs and APOs in the proportion of people who develop a PU within 30 days (10.3% in the mattress group versus 10.7% in the overlay group) (Nixon et al, 2006). Although no difference in overall performance was found between the APMs and the APO tested, a higher percentage of participants requested a mattress change in the APO group 230/990 (23.3%) compared with 186/982 (18.9%) in the APM group; the requested changes were due to comfort and other device-related reasons. This may be a factor to consider in the ambulance if an APO was to be considered, however ambulance journeys have the potential to be much shorter in duration than a stay in an ED. A prospective quasi-experimental study carried out by Manzano et al (2013) that looked at the prevention of PUs in mechanically ventilated patients in an intensive care unit (ICU) comparing APMs with APOs concluded that APMs were more effective than APOs in preventing PUs. They concluded that 17/105 (16.2%) participants developed a new PU grade >2 in the APM group versus 25/116 (21.6%) in the APO group.

If a mattress is to be used in an ambulance and requires a power source, which is a potential when considering an APM or APO, the other demands for power requirement in the ambulance must be taken into consideration. For example, in an ambulance there are multiple electronic items, such as defibrillators etc, that are already on charge, plus the tail lifting ramp also needs power from the ambulance battery system. The requirement for power in the ambulance requires the existence of a sophisticated electronic charging system that constantly monitors, prioritises and diverts charge to the ambulance batteries that in turn supply charge to the devices needing power. A powered APM or APO would be an extra power demand on this electronic charging system. It is therefore prudent to explore non-powered pressure redistributing support surfaces as an option for use on an ambulance trolley. An additional consideration in both powered and non-powered APMs/APOs is the extra height they would add if fitted on top of a standard ambulance trolley mattress, the danger being that it may exceed the height of the trolley bed side rails posing significant safety issues.

Taking into consideration the potential issues with mattresses or overlays that require a power supply, it is pertinent to look at other types of pressure redistributing support surfaces that do not require a power supply. In 2015, Ozyurek and Yavuz carried out a randomised control trial (RCT) (n=105) looking at the prevention of PUs in an ICU setting. No such mattress comparative studies exist in the ambulance setting. Ozyurek and Yavuz (2015) compared two types of viscoelastic foam pressure redistributing mattresses and concluded that there were no differences in the overall incidences of PUs between the two mattress groups. A further RCT by Park and Park (2017) looked at the prevention of PUs in the acutely ill patient, comparing a viscoelastic foam pressure redistributing overlay (n=55) to a standard hospital mattress (n=55). In addition, this study compared interface pressures between the two. The study concluded a significant (p=0.001) reduction in incidence of PUs in the viscoelastic foam pressure redistributing overlay 3.6% compared to 27.3% in the standard hospital mattress group over a 2-week period. The viscoelastic foam pressure redistributing overlay also demonstrated a reduction in interface pressure when compared with the standard hospital mattress. Both of these RCTs were carried out with acutely ill participants, which does not necessarily reflect all patients being transported in an ambulance. However, it was identified by Mains, Graham & Hayes (2020) that the participants in their pilot study were being attended by an ambulance crew because of falls, loss of consciousness, fracture neck of femur, urinary tract/chest infections and strokes. Many of these conditions can be considered an acute illness episode.

Tomova-Simitchieva et al (2018) measured the effects of three different types of mattresses — reactive gel, active alternating air and basic foam — on skin properties of the sacral and heel skin after two hours of loading in a non-blinded randomised, controlled, explorative clinical study with cross-over design. This was a small study (n=15) of healthy female volunteers (median age: 66 years). Participants were acclimatised to temperature and humidity of the room for 30 minutes and then instructed to lie supine on the support surface without moving position, apart from their arms to aid reading a book or listening to music for the duration of two hours. Measurements of the heel and sacral skin were taken in the supine position and measured again after 20 minutes. Several non-invasive measurements were conducted using a variety of instruments to measure transepidermal water loss (TEWL), stratum corneum hydration (SCH), hydration of deeper epidermal and dermal skin layers, skin surface temperature and skin structural stiffness, deformity and elasticity. Tomova-Simitchieva et al, concluded that both the reactive gel and active alternating pressure mattresses caused less skin functional/structural changes when compared with the standard foam mattresses. It is interesting and important to note that the two hours of loading on skin from support surfaces did cause changes in both the skin function and structure particularly in the sacral and heel areas; measured by cutaneous stiffness, which decreased in all three groups, indicating possible structural changes during loading (Tomova-Simitchieva et al, 2018). These changes were demonstrated in healthy volunteers and these detrimental effects may be enhanced in the vulnerable/frail patient who has fallen at home. It may also potentially indicate that patients lying in the same position after a fall could be affected by pressure in a relatively short period of time and that there is a clear need to quickly use the equipment that may help to redistribute pressure loading in the ambulance and en-route to hospital for this vulnerable group of patients. In addition, the Tomova-Simitchieva et al, (2018) study also reported that the active alternating air and reactive foam mattresses appeared to allow better heat convection over standard foam mattresses, indicating a possible advantage over the standard ambulance trolley bed mattress in helping to control moisture and the microclimate between the patient and surface. Alongside careful patient positioning, this may help to reduce the risk and effects of shear and friction during ambulance transportation.

When looking at the evidence for the effectiveness of preventing PUs by the use of pressure redistributing support surfaces, a recent Cochrane review (Shi et al, 2021) that included 17 studies (n=2604) should be included. This Cochrane review looked at the effects of reactive air beds, mattresses or overlays, compared with any support surface, on the incidence of PUs in any population in any setting. This Cochrane review concluded that using reactive air surfaces may reduce the risk of developing new PUs when compared with using foam surfaces. Shi et al

(2021), define reactive air surfaces as "a group of support surfaces constructed of air cells, which redistribute body weight over a maximum surface area (i.e. has reactive pressure redistribution mode), with or without the requirement for electrical power".

The above literature indicates that non-powered reactive air surfaces and viscoelastic pressure redistributing overlays could be used over an ambulance trolley mattress for pressure redistribution. Again, for safety considerations, any type of additional height placed on the ambulance trolley mattress must be securely fitted for transportation purposes. The non-adjustable cot sides on the ambulance trolley correspond with the height of the mattress supplied. However, ambulance trolley beds are fitted with a four-point harness system with additional leg straps that would be used to ensure patient safety. There is a distinct advantage in using a viscoelastic foam overlay in that it could be rolled up for storage and placed in an ambulance cupboard, rapidly deployed when needed and easy to clean. It is imperative that research is carried out in the area of PU prevention in the ambulance by the use of a pressure redistributing support surface.

DISCUSSION

Literature in the area of pressure redistributing support surfaces focuses on them being deployed in the hospital or care home setting and does not directly address what pressure redistributing support surface would be most suitable for use in the ambulance. The recent Cochrane review (Shi et al, 2021) that investigated the effects of reactive air beds, mattresses or overlays compared with any support surface on the incidence of PUs in any population in any setting suggests that using reactive air surfaces may reduce the risk of developing new PUs when compared to using foam surfaces. Participants in the trials covered in this review were on pressure redistributing support surfaces used for a much longer time duration than would be expected for an ambulance journey, and this, in itself, makes comparison and selection of the most suitable pressure redistributing support surface for use in the ambulance a difficult decision. There is also the additional factor of movement in an ambulance to consider, which may increase shear and friction forces in transit. Alongside the effectiveness of the pressure redistributing support surface, there are other considerations to make when choosing which product to use. A pressure redistributing support surface to be used during an ambulance journey also needs to include the following properties: easy and quick to deploy; be suitable for cardiopulmonary resuscitation; can be stored in a cupboard in the ambulance when not in use; simple to clean, whilst conforming to local and national infection prevention and control guidance; quick to pack away; and, where possible, be cost- effective. It must provide a safe and stable environment during the journey because of the movement of the ambulance and the requirement for procedures to be carried out within the ambulance. This would require secure attachment to the ambulance T bed and not exceed the height of the non-adjustable side rails. A non-powered pressure redistributing support surface that could be rolled up and stored away and then rapidly deployed, when necessary, seems to be the ideal and most practical choice for use in the ambulance setting. It is also important to recognise that, in addition to a pressure redistributing support surface, how the patient is positioned is important to help minimise shear and friction forces during the ambulance journey. It is apparent from the literature that there are several possible pressure redistributing support surfaces that are available for hospital beds that could be adapted or manufactured specifically for ambulance use. There is a need for ambulance staff to access a pressure redistributing support surface for use in the ambulance, with all the potential benefits this can bring for patients, and this could be developed through an ambulance service innovation and improvement scheme. Any such ambulance service innovation and improvement scheme looking at the use of pressure redistributing support surfaces in the ambulance should also consider the need for this to be standard in all ambulances for all patients.

In addition, there is a clear need for research in the area to identify what is the ideal pressure redistributing support surface for use within the ambulance. It is imperative that alongside the introduction of a pressure redistributing support surface for use in the ambulance, there should be PU awareness training for ambulance staff, as discussed by Mains, Graham and Hayes (2020) and Schroder and Downie (2021), both articles highlighting that if ambulance staff are to identify patients at risk of PU development there must be an ongoing education programme provided for all grades of ambulance staff. Clearly with an increased PU awareness, screening tools and the right equipment, ambulance services would have the means to start PU prevention in the ambulance when the patient is in transit to the hospital. Ultimately, this would aid in the reduction of the development of new PUs in this group of patients. WUK

REFERENCES

Bisson EJ, Peterson EW, Finlayson M (2015) Delayed initial recovery and long lie after a fallamong middle-aged and older people with multiplesclerosis. *Arch Phys Med Rehabil* 96(8):1499–505. https://doi.org/10.1016/j.apmr.2015.04.012

European Pressure Ulcer Advisory Panel (EPUAP), National Pressure Injury Advisory Panel (NPIAP), Pan Pacific Pressure Injury Alliance (PPPIA) (2019) Prevention and Treatment of Pressure Ulcers/Injuries. Quick reference guide (3rd edn) https://tinyurl.com/jw7v9jh5 (accessed 24 August 2021)

Fulbrook P, Miles S, Coyer F (2019) Prevalence of pressure injury in adults presenting to the emergency department by ambulance. *Aust Crit Care* 32(6):509–14. https://doi.org/10.1016/j.aucc.2018.10.002

Furno UK Limited (2007) Ferno, when it is critical, Pegasus/Pegasus MK 2 Troleyuser manual. https://www.manualslib.com/manual/1729826/Ferno-Pegasus.html (accessed 3 september 2021)

Gefen A (2018) The future of pressure ulcer prevention is here: Detecting and targeting inflammation early. *EWMA Journal* 19(2):7–13

Gefen A, Alves P, Ciprandi G et al (2020) Device related pressure ulcers: SECURE prevention. *J Wound Care* 29(Sup2a):S1–52. https://doi.org/10.12968/jowc.2020.29.Sup2a.S1

Manzano F, Perez A, Colmenero M et al (2013) Comparison of alternating pressure mattresses and overlays for prevention of pressure ulcers in ventilated intensive care patients: a quasi-experimental study. *J Adv Nurs* 69(9): 2099–106

Mains J, Graham Y, Hayes C (2020) Improving pressure ulcer risk identification: a pilot project by ambulance staff. *Journal of Paramedic Practice* 12(2):59–66. https://doi.org/10.12968/jpar.2020.12.2.59

Moncrieff G, Van Onselen J, Young T (2015) The role of emollients in maintaining skin integrity. *Wounds UK* 11(1): 68–74

Myers B A (2008) Wound Management, Principles and Practice. (2nd edn) Pearson Prentice Hall, New Jersey

NixonJ, Granny G, Inglesias C et al (2006) Randomised, controlled trial of alternating pressure mattresses compared with alternating pressure overlays for the prevention of pressure ulcers: PRESSURE (pressure relieving support surfaces) trial. *BMJ* 332(7555):1413–5 https://doi.org/10.1136/bmj.38849.478299.7c

NICE (2014) Pressure ulcers: Prevention and management. Clinical guideline. https://www.nice.org.uk/guidance/cg179 (accessed 24 August 2021)

NICE (2013) Falls in older people: assessing risk and prevention. Clinical guideline. https://www.nice.org.uk/guidance/cg161 (accessed 24 August 2021)

Nuffield Trust (2020) Ambulance response times. https://www.nuffieldtrust.org.uk/resource/ambulance-response-times (accessed 24 August 2021)

Ozyurek P, Yavuz M (2015) Prevention of pressure ulcers in the intensive care unit, a randomized trial of 2 viscoelastic foam support surfaces. *Clin Nurse Spec* 29(4):210–7. https://doi.org/10.1097/nur.0000000000000136

Park KH, Park J (2017) The efficacy of a viscoelastic foam overlay on prevention of pressure injury in acutely ill patients: a prospective randomised controlled trial. *J Wound Ostomy Continence Nurs* 44(5): 440–4.

Public Health England (2017) Falls and fractures consensus statement supporting commissioning for prevention. https://tinyurl.com/jbzfmp7p (accessed 24 August 2021)

Schroder K, Downie F (2021) Assessment of pressure ulcer risk by ambulance staff in the pre-hospital setting. *Wounds UK* 17(2): 69–73. https://tinyurl.com/4ty79nu8 (accessed 28 August 2021)

Shi C, Dumville JC, Cullum N et al (2021) Reactive air surfaces for preventing pressure ulcers. *Cochrane Database Syst Rev* 5(5):CD013622. https://doi.org/10.1002/14651858.cd013622.pub2

Stryker USA (2018) Product information embossed on to the Striker Power-Pro XT trolley bed mattress. https://tinyurl.com/3ktbxmr3 (accessed 28 August 2021)

Tomova-Simitchieva T, Lichterfield-Kottner A, Blume-Peytavi U, Kottner J (2018) Comparing the effects of 3 different pressure ulcer prevention support surfaces on the structure and function of heel and sacral skin: An exploratory cross-over trial. *Int Wound J* 15(3):429–37. https://doi.org/10.1111/iwj.12883

Wood J, Brown B, Bartley A et al (2019) Reducing pressure ulcers across multiple care settings using a collaborative approach. *BMJ Open Quality* 8:e000409. https://doi.org/10.1136/bmjoq-2018-000409