Pressure sores as a complication in patients with spinal cord injury. Prevention and treatment

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ABSTRACT

The present study critically examined pressure sores/ulcers as a seminal side effect associated with patients who have suffered spinal cord injury. The statistics show that a large percentage of this patient group develops pressure sores due to prolonged bedrest and inactivity. The aim of this study was to present a review of pressure sores treatment tactics that specifically pertain to patients who remain immobile due to spinal cord injury. The available methods for prevention and treatment of pressure sores either conservatively or surgically were assessed. Source material for this review was chosen according to its specificity to pressure ulcers and spinal cord injury. The choice of treatment is decided according to the categorization of pressure sores into 4 stages. The study focused on surgical treatment via the use of flaps, that has been shown to be revolutionary in handling advanced pressure ulcers (stage III and IV), yielding a large percentage of successful operations. The surgical intervention was then extensively analysed in terms of operative procedure, postoperative management andpossible complications. In conclusion, flap reconstruction was found to be successful in optimizing the treatment of pressure ulcers in patients with spinal cord injury.

Key Words: Pressure Sores, Spinal Cord Injury, FlapReconstruction, Pressure Sores'Treatment

Introduction

Patients suffering from spinal cord injury (SCI) represent a population susceptible topressure ulcers/sores. The prevalence of pressure ulcers is highly variable and seems to be pertinent to the degree of spinal lesion. According to a recent literature review, 47.7% of patients with paraplegia and 33.9% of patients with quadriplegia are reported to suffer from pressure ulcers (1,2). Pressure sores usually form in, but are not limited to, the ischium, the femoral trochanter, the sacrum, and the heel (3,4). In quadriplegia, the most common site is the ischial tuberosity, representing 28% of all cases. Different categorizations of pressure ulcers have been reported over the years; however, the one that prevailed and is widely applied nowadays is the NICE. According to the latest parameters from 2015, four categories of pressure ulcers have been identified. Each category (stage) dictates the method of appropriate treatment for a given case (7). Category I includes lesions with intact skin and redness which does not

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blanch. Category II includes lesions with partial loss of skin's layers or blister filled with clear fluid. Category III includes lesions with total loss of skin thickness, whereby the muscle and bone are not visible. Category IV includes lesions with total loss of tissue thickness, whereby the muscle and bone are visible (7).The current strategy for preventing and treating pressure sores consists of three main factors: the evaluation of a patient's risk for developing an ulcer, the adaptation of an adequate prevention scheme for patients in high risk for ulcer development and ultimately, the ulcer treatment (8).

The purpose of this study was to present a review on pressure sores' management in patients with SCI. Specific emphasis was placed on the surgical approach with flap reconstruction that has been shown to optimize the recovery of these patients and ultimately improve their quality of life. Research was conducted using Google Scholar online database to identify material that was relative to the specific group of patients suffering from SCI and developing pressure sores, as a result. Articles that were chosen were specifically assessed for their recency, for the review to be up to date with the latest standards of available treatment. In contrast, articles that were rejected included: studies still undergoing the experimental phase, studies often employing a very limited sample of participants and studies that yielded questionable results pertaining to the surgical treatment of pressure sores. Unsubstantiated sources of this type would otherwise compromise the focus of this study to identify the most effective available treatment (Table 1).

Discussion

1. Prevention of Pressure Sores

The basic prevention measures include the adjustment of pressure on the patient's skin and the use of specialized equipment (e.g. Alternating pressure mattress), as well as therapeutic interventions focusing on the application of bandages and the acquisition of a balanced diet rich in protein, iron, vitamin C and zinc. (8) Treating any condition which contributes to sore development such as diabetes mellitus and hypoalbuminemia, is also of vital importance. According to the suggestions of NPUAP, EPUAP, PPPIA, it is ultimately important to educate the patients and their families on managing pain and infection (9). The acronym, «SSKIN» represents the five steps in the prevention of pressure sores in patients with SCI. Each letter in the acronym stands for the words: **S**urface, **S**kin inspection, **K**eep moving, **I**ncontinence/moisture, **N**utrition and hydration. Specifically, healthcare providers but also family members should inspect patient's skin, as well as regularly move patients to avoid constant pressure in specific areas. Moreover, the patient must be inspected for incontinence and general moisture to the prone areas of the body so that the skin is being kept dry and clean. Lastly, the patient needs to receive healthy nutrition and adequate hydration. Another seminal prevention measure is the "five pillow rule" that employs the use of pillows to support patients' body. Pillow 1 is placed under the feet to elevate the heel. Pillows 2and 3 are placed between the ankles and the knees respectively, if the patient is lying sideways. Pillow 4 is placed behind the back and pillow 5 under the head (10).

2. Treatment of Pressure Sores

The categorization of pressure sores has constituted a valuable tool in deciding the appropriate treatment for a given case. The treatment of pressure ulcers according to the respective category is an issue that has repeatedly occupied the medical community. According to the international guidelines, for categories I and II the conservative approach is suggested while the surgical approach is preferred for categories III and IV. In the case of the conservative approach, the process begins with the use of a bandage which fosters a humid environment appropriate for healing along with an antimicrobial bandage. Specialized bandages must have the following properties: (i) maintaining a sterile content, (ii) provide thermal insulation, (iii) guard against bacteria and infection, (iv) provide water absorbency, (v) protect against skin damage after removal and (vi) ensure patient's comfort when the dressing is changed (8). Hyperbaric oxygen therapy and electrotherapy are also used. The use of nutritional supplements for patients who suffer from nutritional deficits is recommended. The use of systematic antibiotics is not required, except from cases where infection is proven by tissue cultures. Antibiotics are initially provided empirically and are then de-escalat-

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ed according to the antibiogram. The infection of an ulcer can amount to inflammation of the soft tissues or bone, cellulites, formation of abscess, bursitis and osteomyelitis of the bone near the trauma (11). Pressure sores are also a common cause of bacteraemia in patients with SCI (12). Ulcer cultures most commonly grow mixed flora (23.5%), followed by Enterococcus sp. (20%), no growth (19.1%), and Pseudomonas aeruginosa (11.3%) (13).

Applying monitored degrees of negative pressure has been proven beneficial for various kinds of trauma, as it can speed-up recovery time by boosting wound healing. Negative pressure levels are shown to be most effective at 125mmHg below ambient pressure, especially when applied in a circular way for five and two-minute intervals. The use of negative pressure is shown to eliminate the interstitial fluid, lessen localized edema and improve blood flow, resulting in the decrease of bacterial numbers in the infected areas. Vacuum-Assisted Closure (VAC) is an effective device that utilizes the benefits of negative pressure to prepare trauma for surgery by accelerating healing, thus significantly reducing the chances of complications as well as prospective hospitalization time (14,15). VAC is also shown to be successful in the treatment of non-healing wounds that would otherwise remain open (primary healing) (16,17). In general, the conservative treatment of ulcers is long lasting, requires the use of specialized methods and generates large hospitalization costs that add a great economic burden to the health care system.

The conservative approach is ineffective when it comes to ulcer stages III and IV, thus the intervention of plastic surgeons for the creation of coverage with a tissue flap is deemed necessary (3,18). Surgical reconstruction combined with rehabilitation and training of the patient and his/her family reduces the chances for postoperative reoccurrence of the pressure sore (3). The choice of flap type depends on the affected site, the size of the ulcer and any past surgeries on the patient in the same area (16-21). For the surgical treatment of pressure ulcers, there are two available approaches: the one-stage reconstruction and the two-stage reconstruction. One stage reconstruction consists of surgical debridement and flap reconstruction in one procedure. Two-stage reconstruction includes debridement and final reconstruction performed in two different operations, with a six-week interval (22). Studies do not indicate any major statistical difference in the number of recurrent pressure ulcers or other surgical complications in SCI patients, who were submitted to reconstruction surgery in one or two stages. Thus, the decision of approach lies on the surgeons and the means available to them (23).

Flaps used for ischium pressure ulcer reconstruction should have good vascularity to ensure survival, to facilitate the control of infection and to provide adequate size and volume to eliminate empty space (27). Ischial pressure ulcers are usually observed in paraplegic patients using a wheelchair, where tissue pressure amounts to 80-100 mmHg based on the anatomical position. (28) The vicinity of the ischium with the perineal area makes the area prone to infection from faeces or urine, leading to skin disruption and enduring infection (29,30). Chronic infection of the site causes osteomyelitis of the ischial tuberosity and/or ischial bursitis, accompanied by necrosis of soft tissue (31). The coverage of deep and superficial areas of the deficit by separate flaps has the advantage of reconstructing the soft tissue deficit in the exact position that is anticipated, and the double flap technique allows for the reconstruction of soft tissue layer by layer, granting the advantages of each flap (32,33).

Trochanteric ulcers may be difficult to handle, particularly in cases of heavy bone engagement that demands a wide surgical debridement. The lingering wound is deep and substantially large thus, reconstruction must guarantee a total fill of all the dead spaces. Ultimately it must be covered with enough tissue to optimize healing and decrease the chance of recurrence. In SCI patients who develop trochanteric ulcers, muscle or cutaneous flaps are the ideal choice because the use of sufficient, viable volume is allowed. In such cases, the flap can be combined to achieve an optimal result. Trochanteric pressure ulcers are usually associated with osteomyelitis. Thus, surgical debridement should be extensive to remove all infected or non-viable soft and bony tissue. The gold standard is Gilderstone arthroplasty (30). Rectus femoris, vastus lateralis, and gracilis are muscles with nearby pedicles, easy to use as musculocutaneous flaps using a large skin paddle. The dissection of each flap is made

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through a single incision on the thigh and the donor site is then easily sealed by direct suture. The arc of rotation allows the flap to reach the deep surface of the deficit without extension. The combination of a muscle flap which is placed deeply and is covered by a musculocutaneous flap allows for full coverage of the deficit and its surface. In case of a single muscle flap, the surface is covered with a skin paddle, or skin graft (1).

For a long time, reconstruction of soft tissues around the area of the heel has posed a challenge for reconstructive surgeons. Reconstructive surgery in patients who also suffer from SCI exacerbates this problem. Due to prolonged immobility, the skin and soft tissues usually atrophy, especially in the limbs. Over the lateral malleolus, the primary closure is usually impossible due to bony prominence and the lack of available mobile and healthy local skin. Local skin flaps (rotation, transposition and advancement) are associated with similar problems. Skin grafts are usually set to fail as a result of direct exposure to bone, tendons and ligaments. The transposition of a microsurgical free flap is efficient and may address many of the limitations which are associated with various local and distal choices. However, this is a demanding and time-consuming technique that may also not be appropriate for certain patients (26).

3. Preoperative and postoperative management

Analysis of pressure sores includes deficit evaluation in relation to site, scale and depth. When the deficit involves an important percentage of the skin's surface, reconstructive options may be limited to skin grafts for extensive coverage or expansion of successive tissue. The components of a deficit may include one or all of the following: skin, nerves, mucosa, fascia, subcutaneous tissue, joint cartilage, muscle, bone and vessels. Each section affects the function and form on the site of the deficit. The choice of the appropriate reconstruction method is based on viability and relevant importance of replacing each section of the deficit. Ulcer analysis must also include the vascular status and the presence of infection in the exposed structures. Evaluation of the vascular status can be achieved with non-invasive means, such as Doppler ultrasound and Magnetic resonance angiography, or by invasive means such as angiography (25). The design of the flap is of vital importance. The finalized flap design is intended for stable transposition, gradual expansion or microvascular transplantation and must be based on the deficit's actual size. The initial design of the flap has an effect on future procedures, if the deficit recurs or demands review. In general, the making of the flap is delayed until sufficient surgical debridement is conducted. If simultaneous elevation and dissection occurs, the design of the flap must be fitting the maximum expected scale of the deficit. Identifying high risk patients is also significant. Smoking, obesity, cardiovascular diseases (hypertension, peripheral vascular disease), immunosuppression and pulmonary diseases are important factors that must be taken into consideration. These crucial factors will determine the selection of suitable patients and the selection of the right type of flap, as well as the success and longevity of the final result.

The patient should be positioned in such a way so as both donor and recipient sites are visible. If correct positioning cannot be achieved, then the placement of the patient must provide maximum visibility of the recipient site at least, especially if the required dissection is large (25).

Postoperative management of the flap is equally significant for the success of the operation, as the reconstruction itself. Maintaining appropriate position, temporary immobility and proper bandaging of the surgical wound are crucial factors that can promote a successful result. Pressure on the flap's base must be avoided during the postoperative period. When possible, the operated body part should be kept raised to avoid contact with any surface. If the site of the flap does not have protective sensibility, it should be placed in independent position. The use of a specialized bed with air mattress can be helpful in avoiding pressure of the dependent areas in patients with SCI (26). Restrictive bandages must be avoided, mostly around the area of the flap's base, where pressure in vascular stem may compromise the flap's circulation. The flap must be monitored for any circulation problems during the early postoperative period. Excessive movement in the flap site should be avoided by filling the areas adjacent to the nested site of the flap. Circular plasters must be avoided due to the threat of pressure that could result in postoperative edema and difficulty

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in monitoring the flap's blood flow.

In general, a closed drainage system is applied on the donor and recipient sites after closing. The drains are not removed until the patient is mobilized, since immobility can result in increased risk for oedema and subsequent seroma. Drains in close proximity to the tissue expander or the prosthetic implants must be removed as soon as possible to avoid the risk of infection. When the drained fluids are reduced to 20 mL in a 24hour period, the drain system can be removed. If possible, the drainage systems are removed after the 10th postoperative day to avoid possible infection of the wound during the removal of the system (25). Intraoperative antibiotics are recommended when the flaps are placed in pressure sores whose cultures were positive. Cultures of the area of the deficit can determine the necessity for postoperative treatment with antibiotics. The continuous use of postoperative antibiotics must be in accordance with the results of the wound's cultures.

4. Complications

Reconstruction with muscle and musculocutaneous flaps has repeatedly been praised for its safety and reliability. Its success has now led surgeons to opt for more complicated procedures, especially since they can preserve and enhance function and form. However, like all procedures these too can result in complications. Complications regarding the use of muscle and musculocutaneous flaps are due to mistakes that fall into three categories: judgement, technique and patient management. Frequent complications comprise seroma, hematoma, superficial skin necrosis, wound separation, insufficient coverage of the deficit, infection and partial or total loss of the flap. By assessing these complications in relation to the three categories, the surgeon should be able to comprehend the cause of a given complication to prevent future problems (26). Failure of the surgeon to judge correctly often stems from inadequate preparation, inappropriate design of the flap or insufficient knowledge of anatomy. The surgical technique directly impacts the result of any procedure. Tissue manipulation, specifically of vascular pedicles, is of major importance for the flap's success. Vessels can be compromised in any stage of the surgery and are subject to spasms, shear, and twist. In order to avoid that, the surgeon can place temporary sutures between the flap's skin and the muscle or the fascia beneath it, to prevent tearing of the perforating vessels. Avoiding Eschewing skeletonization of the vascular pedicle if not required, is also critical to avoid spasms and injury (26). Ultimate flap loss may be ensued by intrinsic or extrinsic factors. Intrinsic factors mainly refer to insufficient blood supply, which is the main reason for the flap to be jeopardized. Extrinsic factors may involve infection, hypotension, and vasoconstricting agents. Moreover, hematoma could compromise the flap by generating compression or tension. Surgical review of the flap must be prompt when failure is suspected. Complications relating to the donor site comprise fluid gathering due to dead space (seroma, hematoma) wound separation, infection and injury in adjacent structures in the process of preparing the flap.

Miscalculations in patient coordination are a usual cause of postoperative complications. Such miscalculations in patients that receive reconstruction with a musculocutaneous flap include undermining any lingering medical conditions that are not related to the surgery, poor assessment of intravascular volume status and failing to observe the flap's viability and blood supply. Specifically, patients suffering SCI and pressure ulcers, that undergo debridement and reconstruction with musculocutaneous flaps will usually experience complications associated with spasticity due to the upper motor neuron syndrome. (35,36) When reconstruction is performed using a musculocutaneous flap, spasms can cause premature loosening of the sutures, flap stretching, prolonged recovery and possible failure of the reconstruction. More than 80% of patients with SCI present spasticity, causing significant further disabilities. Severe muscle spasms can be caused by various stimulating factors such as heat, cold and stretching of the urinary bladder (37,38). The symptoms are hard to control with medication. Often, muscle spasms can be intense in the postoperative period after treatment for pressure ulcers (39).

Finally, another complication is the recurring ulcer and osteomyelitis that often require surgical debridement and long-term treatment with antibiotics, resulting in prolonged hospitalization. These cases often re-

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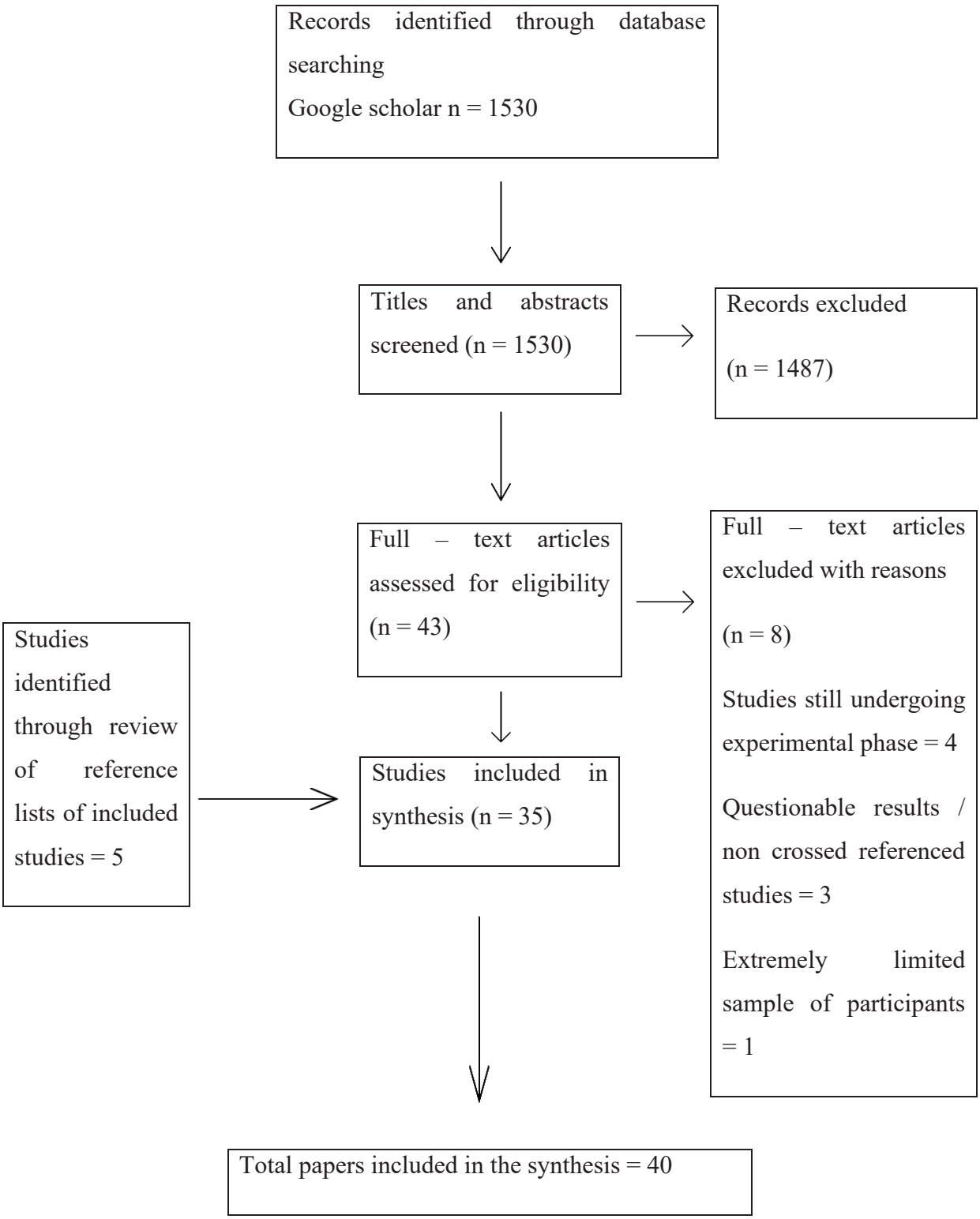
Table 1



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quire a continuous dressing regime after the period of hospitalization. Following recovery, the unstable scar tissue makes the site susceptible to recurring ulcers, and avoiding pressure to the unstable scar tissue by respectively placing the patient often results in simultaneous pressure ulcers in other sites. Simultaneous trochanteric and ischial pressure ulcers, commonly referred to as the dual defect, present a reconstructive challenge (40).

Conclusion

The present study examined a serious problem experienced by patients with SCI. A large percentage of these patients will develop one or more pressure ulcers during their lives. Consequently, hospitalization time as well as morbidity rates are increased causing a great deal of uneasiness and psychological distress to the patients and their families. The issue of pressure sores in patients with SCI has generated global concern in the medical community, leading to the publishing of many studies regarding treatment. The treatment of pressure ulcers begins with prevention; thus, it is imperative to educate the patient's family in order to avoid the creation of an ulcer in the first place. Failure to prevent pressure ulcers results in the mandatory classification of the ulcer to identify the stage of the ulcer and determine how to treat it. In stages I and II the conservative approach is suggested while in stages III and IV the surgical approach with the use of flaps is preferred. Surgical treatment involves both surgery and appropriate management in the postoperative period. For this reason, the collective effort of several specialties such as orthopaedics, nutritionists, physiatrists, plastic surgeons as well as the contribution of the nursing staff and the physiotherapists is a huge undertaking in the medical community. Flaps revolutionized the treatment of advanced pressure ulcers, providing radical solution for the first time in history. Treatment with surgical flaps offers hope for recovery, improves the quality and prolongs the lives of these patients, and most importantly improves the psychology of all those involved in this situation, including families and caregivers.

Conflict of interest

The authors declared no conflicts of interest

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