



## Bedsore and strategies for preventing and treating the bedsore

Yashas M S, Preeti S\*, Amit B Patil, Shailesh T

Department of Pharmaceutics, Industrial Pharmacy, JSS College of Pharmacy, JSS Academy of Higher Education and Research, Sri Shivarathreeswara Nagar, Mysore - 570 015, Karnataka, India



### Article History:

Received on: 24 Nov 2020  
Revised on: 10 Dec 2020  
Accepted on: 29 Dec 2020

### Keywords:

Pressuresore, management, skin necrosis, pressure, complication, tissue hypoxia

### ABSTRACT

The best recognized and also the most widespread example of tissue necrosis is bedsore. A bedsore is localized damage to the skin and other underlying tissue, usually over a bony prominence, as a result of prolonged, unrelieved pressure. The cause of bedsore is shearing forces; friction, moisture, and constant pressure contribute to the development of bedsore. Hospital research shows that bedsores develop from 3% to 4.5% of patients during prolonged hospitalization and Sores develop from 25% to 85% of patients with spinal cord injury. The doctor and nurses will regularly examine the patient who is at risk of developing bedsore and inspect each pressure sites at least twice a day. Doctors and nurses are important warriors who manage bedsore treatment effectively. This review describes the new strategies have been used to prevent and management of bedsore such as inexpensive foam devices, anti-pressure devices, air-filled equipment, a sheet of hydrogels, wound vacuum-assisted closer, skin bioprinting, and Lab VIEW virtual instrument.

### \*Corresponding Author

Name: Preeti S  
Phone: +91-7019803044  
Email: [preethis@jssuni.edu.in](mailto:preethis@jssuni.edu.in)

ISSN: 0975-7538

DOI: <https://doi.org/10.26452/ijrps.v12i1.4180>

Production and Hosted by

IJRPS | [www.ijrps.com](http://www.ijrps.com)

© 2021 | All rights reserved.

### INTRODUCTION

The pressure sore was named as "BED SORE" in the literature of English and a decubitus in the nineteenth century (Parish *et al.*, 2012). The word decubitus ulcer came from the Latin word decub called "lying down". This is a misnomer, however, as a significant percentage of these kinds of sores occur when the patient in a seated position. Therefore, the word "pressure sore" should be also used as it is more accurate and characterizes the pathophysiology (Singh *et al.*, 2013). Bedsores were areas

that injured skin and tissue that progress when prolonged pressure shuts off flow to sensitive areas of the body, especially buttocks, sacrum and heels, hips, maleolus, scapula. The bedsores usually arise from the small vessel thrombosis (Bennett *et al.*, 1989); this causes gangrene, sloughing and necrosis, spreading more or less rapidly and extensively according to the tissue's resistant strength. The causative infection is often of a virulent form of streptococcus that causes necrosis. Bedsores will develop rapidly, progress fast, and are often problematic to cure. Whereas bedsore has troubled doctors and patients since ancient times, its lack of interest in many doctors has resulted in insufficient preventive care and lack of understanding of the treatment (Bergert *et al.*, 2009).

In the late 19th and early 20th century's bedsore seen most frequently young patients who had a variety of wasting diseases, including tuberculosis, osteomyelitis, and chronic renal disease. The 14.8 per cent annual prevalence rate among patients who were admitted in hospitals and generally in the ICU and patients between 70 and 79 years of age (Amlung *et al.*, 2001). General hospital research shows that bedsores develop from 3% to 4.5% of

patients during prolonged hospitalization. Sores develop from 25 per cent to 85 per cent of patients with spinal cord injury. Sores appear in a patient with quadriplegia and paraplegia during their initial hospital stay in 20 per cent to 40 per cent. One major rehabilitation hospital confirmed that in 1988, the estimated price to treat a severe pressure sore was \$58,000 (Adkins *et al.*, 1988).

In general, the possible causative factor (friction, shear, stress) must be removed. Shear forces, Pressure, and friction may induce microcirculatory compression leading to ischemia that characterized by inflammation and tissue anoxia. Tissue anoxia results in ulceration, cell death, and necrosis. The infected area needs good cleaning and dressing. Wound healing requires Topical antiseptics and antibiotics are used during the cleaning process, Appropriate protein, zinc supplements, and vitamin C and can be recommended if there is a diet deficiency and cleansing and pressure irrigation, ultrasound therapy, laser, hydrocolloid dressing, alginate dressing, Nanosilver dressing, creams and ointments, biofilm, negative pressure therapy, skin substitutes (bioengineered skin) Bedsore will grow quickly and is often hard to treat. There are several ways to help avoid some bedsores and help to heal. Nowadays, ulcer treatment is designed with the objective of reversing the factor that originally caused the ulcer.

Doctors and nurses are important warriors who manage bedsore treatment effectively. The nurses should analysis of Patient and bedsore, managing of tissue loads, ulcer treatment, controlling of bacterial colonization and infection, operative pressure repair, training and enhancement of quality (Beckrich and Aronovitch, 1999). This review summarizes the latest development in the management of bedsore by new technologies and bedsore management.

### Pathophysiology

Review of the pathophysiology and management of this problem is timely because of internists increasing role in geriatric care and extended care facilities, the great impact of pressure sores on patient rehabilitation and health care costs, and the frequent need for surgical consultation (Kanj *et al.*, 1998).

The very first thing mentioned in bedsores development is a dusky red discolouration, due to passive skin hyperemia. It was accompanied by a purplish tinge, which gradually changes to black as a result of gangrene and causes skin necrosis.

Skin necrosis is mainly for interference with the skin blood supply (Yastrub, 2010). The blood flow to the

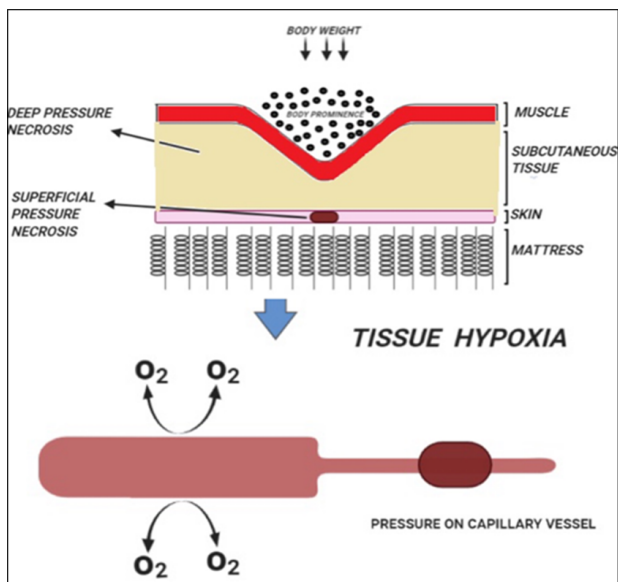
skin is the subcutaneous tissue and any sustained pressure that is sufficient to obstruct the circulation for even more than several hours can result in tissue death and ulcer that often affects mainly for bedridden patients. The most commonly involved areas are those that are exposed to pressure over the trochanters, sacrum, the scapula, the spinous vertebra process. The outer malleoli, heels and internal condyles of the humerus. Bedsore may happen in highly susceptible tissue on any part of the body and it is most frequently the results of continues the pressure between beds.

The prime known and most widely recognized example of tissue necrosis is bedsore. Since many conditions lead to the improvement of pressure sores, 4 are critical: shear forces pressure, friction, and moisture (Cichowitz *et al.*, 2009). The force applied to a unit area is the key element. Extra pressure over bony prominence contributes to a wide gradient of 3-dimensional pressure.

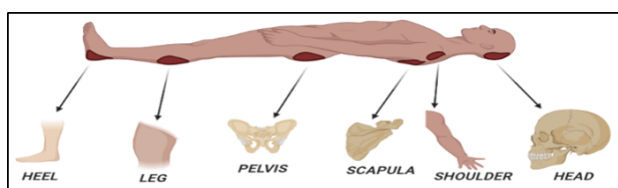
Scientific investigation on these pressure gradients shows that the capillary arteriolar limb pressure in the skin was 32 mm Hg; the midcapillary pressure is 20 mm Hg; the venous limb pressure was 12 mm Hg; the sacrum and the trochanters can be large as 100 to 150 mmHg (Houle, 1969). When an average 70 kg person with the total body surface of 1.8 m<sup>2</sup> would be in an equally distributed supine position, the average pressure would be 5.7 mm Hg at any given point. However, this is not distributed equally but focused in the focal areas, usually over a bony prominence. For comparison, the pressure exerted on the toe of a ballerina is 2600 mm Hg while the force exerted on any given unit of skin when a patient is floating in a liquid is 20 mm Hg. Friction is a force generated when two contact surfaces move over each other, such as when a Pearson is dragged along all bedsheets. The friction effect is the displacement of the exterior defensive stratum corneum, accelerating the initiation of ulceration. The ultimate major causative influence is moisture caused by faecal either urinary soiling either diarrhoea, which increases the risk of the formation of pressure sore by fivefold (Allman *et al.*, 1986) are shown in Figure 1.

### Complications of Bedsore

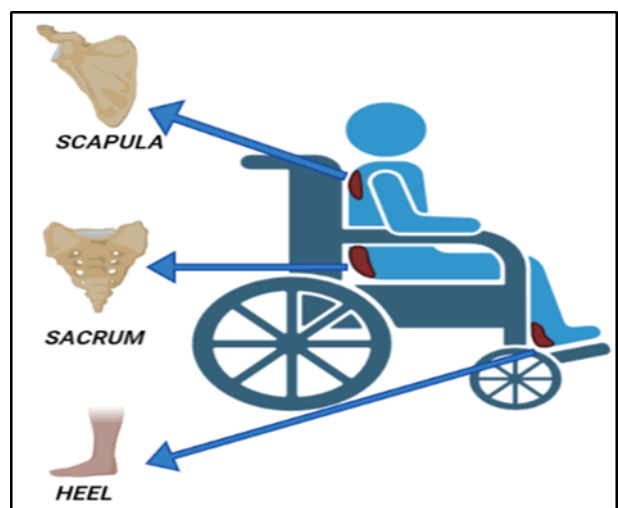
1. weird changes in skin colour or texture
2. Dusky red, slight discoloration caused by skin hyperemia. It is supported by a purplish tinge, gradually turning to black as the results of gangrene (Desforges and Allman, 1989).
3. Edema



**Figure 1: Pathophysiology of bedsore**



**Figure 2: Common sites of pressure ulcers for people who always stay in bed**



**Figure 3: Common sites of pressure ulcers for people who always stay in a wheel chair**

4. Pus like draining
5. A skin layer that feels warmer either cooler to a touch than in another areas
6. Tender regions.

**Common sites of pressure ulcers**

When there is too much pressure on your skin for an extended period, it diminishes the blood flow to that

area which might lead to necrosis and the friction to your skin caused during bedridden as well as during use of a wheelchair. People who always stay in bed can be at a higher risk of necrosis in the area of the body like the heel, leg, pelvis, scapula, shoulder as shown in Figure 2, and the people who always stay in wheelchair cause necrosis in the region like the scapula, sacrum, heel as shown in Figure 3.

For wheelchair users, bedsores sometimes occur on the skin over the following sites.

**Stages Of Bedsore**

There are several stages of bedsores that affect our skin. In the initial stage cause redness, erythema, and skin epidermal inconsistency, in the second stage, it causes swelling and blister forming, in third stage cause loss of whole thick skin, heavy crater, and the final stage cause Skin loss of full-depth down to muscle as well as bone and all the treatment for their respective stages are shown in Table 1.

**Techniques For Preventing As Well As Treating Bed Sores**

**Antipressure devices**

Antipressure systems are also suggested as precautionary action for persons at major risk and also for patients that already have ulcers (Andersen et al., 1982). The antipressure systems should seek to reduce the pressure on bony prominences towards that range only around 32 mmHg the commonly aggred range over which capillary blood flow will cause as well as outcome in tissue ischemia.

Antipressure systems can also be static and dynamic. Static systems maintain immobile except as a reaction to patient motion, and this theoretically causes pressure equalization under the patient by reallocating the patient mass. Samples of static systems include air, gel, foam as well as water mattresses. Dynamic systems need energy and also have movable components; Examples include alternating air beds, air-conditioned bed and low air loss beds. Within each of these categories, there are pressure relieving and pressure reduction devices (Seiler and Stahelin, 1985). Example: metron anti bedsore elevating system.

**Foam Devices**

Modern medicine requires high demands for the ideal cover to treat burns, wounds, and ulcers. Foam is the widely use of material for pressure relieving. Foam materials could be filled and are promoted with different thicknesses, rigidity and strength. The compaction and conformability of the foam could be calculated as per the percentage with indentation load deflection (ILD). The strength

**Table 1: Stages of bedsores and treatments**

Stages	Causes	Treatment	Example
1st-Stage	It causes redness erythema, skin epidermal inconsistency.	Air filled equipment's	Anti-decubitus cushion, MCN air pump and bubble mattress, kosmocare spiral air mattress
2nd-Stage	It causes swelling and blister forming sore.	Wound vacuum assisted closer.	V.A.C Therapy system, snap wound care system
3rd-Stage	Loss of whole thick skin, heavy crater	Sheet of hydrogels	Suprasorb, medela
4th -Stage	Skin loss of full-depth down to muscle as well as bone	bioprinting	Inkjet-based bioprinting, laser-assisted bioprinting

needed to compress the foam selected per cent of its thickness. Features of foam surfaces linked with low interface pressures include an acceptable thickness of three to four inches, 25 per cent ILD with a load and foam density of 30 lb in between 1.3 and 2.5 lb/cu ft. More possibly, the foam making will increase the interface pressure. ILD and memory reduce the foam deteriorate over time. Thus the characteristics relieving pressure are lost. Foam items are simple to use, lesser weight as well as cheap. The main drawback is that they can hold liquid, are hard to clean when soiled and are costly for dispose of (Burnell, 1969). Example: anti-decubitus cushion.

#### **Air filled equipments**

Air filled equipments are widely adapted. Static air mattresses are preferably equipped with air cells as well as bladders. It can equalize When a patient is not trying to move, the pressure inside each cell (Soonthornkiti and Jearanaisilawong, 2013). Thus every part of the body in touch with support surface is hypothetically at similar pressure of the tissue interface. Cushions and mattresses are constructed in an alternative design from rows of interconnected, air-filled cells which are individually displayed alternating pressure pads, air suspension mattresses, or air suspension mattresses are dynamic air-filled items. This filled air effects in a reallocation of body mass off bony prominences, and differ in pressure gradients are created to increase blood flow. It also leads to prevention of Bedsores. Example: MCP air pump and bubble mattress, kosmocare spiral air mattress.

#### **Water and gel filled equipment**

Water filled equipments are promoted but used as minimum frequently in maximum settings. The

patient's mass replaces the water in a mattresses so that the supported surface proves the body as well as the patients float on the surface. While water is cheap and the components are commonly easier to wash, the use of water-filled products is restricted due to the mass of loaded systems, the time take to install, the need to monitor the fluid level and the potential for leakage. Gel-filled equipment are the variant of water-based equipment and gel filled equipment are a variant of water-based systems and overlays and beds filled with gel are also marketed. Such products are typically more easy to wash, long-standing, but they are always heavy and costly (Agostini *et al.*, 2001). Example: anti-air cure air bedsores, PAXMAX water bed.

#### **Sheet of hydrogels**

A sheet of hydrogels is a solid and non-sticky gel sheet consisting of a connection of hydrophilic cross-linking Polymers that could accumulate more amounts of water without breaking down its structural integrity. They have a fixed shape in contrast to the amorphous hydrogel. They could be used as a medium for skin treatments, and to remove their wound exudate mass. These were durable for water vapor as well as oxygen, but it's not water or even bacteria, but they provide better visibility of a wound because of their translucent behaviour.

These could be used for mild to mildly exudative sores and for the autolytic debridement of pressure sores in Stages two as well as three. Patients cannot be used to exude heavy sores (Edwards and Goheen, 2011). Example: Suprasorb, medela.

#### **Wound vacuum-assisted closure**

Vacuum based closure is done with polyurethane foam followed by negative vacuum pressure during bedsores. The sore is loaded with foam, and a film is



sealed. The vacuum tube is constantly incorporated and utilized. This method is developed on infected sores as well as fistula wounds (Schimp *et al.*, 2004). Example: VAC therapy system, snap wound care system.

### Skin Bioprinting

Thickness skin injuries as well as serious burn wounds, are significant causes of mortality and morbidity. Bioprinting invention has been suggested as a method of distribution to efficiently position the skin cells on the wound. One of the benefits of skin bioprinting seems to be that it also has the potential to reproduce the native tissue architecture with a strong degree of accuracy; bioprinting can reproduce the wound's compositional complexity. It seemed to be effective without detrimental adverse effects or intense scarring. An alternative to specific skin grafting was the development and application of many biological skin substitutes. Cell-based therapy would be another effective option to repair and recover skin tissue. Bioprinting invention has been suggested as a method of delivery to effectively place the skin cells on the wound. Printing allows two or more cell types to be positioned in distinct positions relative to one another because they can be incorporated into the printed structure, leading for recovery to the skin with pigmentation and hair. Ultimately, printing is perfect for large wound areas which protect different parts of the body as the tissue composition can be controlled and geometry controlled (He *et al.*, 2018).

The skin bioprinter we have built is designed to print one layer of skin at a time. To this point, the wound is scanned for topography and wound area. The scan is converted to a 3D picture used by the printer to precisely map a wound path. Inside a fibrin/collagen solution, culture-expanding keratinocytes and fibroblasts and are suspended separately.

Initially, fibroblast mixture is printed. Even if they are printing, the mixture is cross-linked to thrombin that is carried in a different cartridge. After printing the fibroblasts, the keratinocytes were also printed on over fibroblasts using the same technique. The previous scan indicates the quantity needed for every application of the cell type. The scan leads to more accurate outcomes, whereas the mixture of cell or gel imitates the natural skin composition and results in faster curing and better cosmetic results with low scarring. Because it still is a new area, several groups also made great progress with skin bioprinting using different methods since bioprinting is still in early stages, scientist is trying to refine the cell delivery mechanism through a

variety of approaches. Some many hydrogels were tested in order to print and evaluate cell migration via them. Scientists also are researching the use of laser printing cells in smaller amounts than skin bioprinters require (Murphy *et al.*, 2013).

### Labview Virtual Instrument

A new approach is proposed to develop the traditional bed sore prevention mattress, mattress is separated in areas to be managed respectively, multiple grouping of stress sensors will be used to calculate the pressure signals in each region, the pressure signals are then collected towards the computer (Su, 2014). The virtual Lab-VIEW device is developed to examine the evaluated pressure data and measure the condition of each part of a human body which has been pressed continuously. The LabVIEW device sends control signals to corresponding mattress pumps for the sections that are alerted by the device (Bergstrom *et al.*, 1995).

### CONCLUSIONS

A bed sore is a massive problem for geriatrics persons. In certain cases, risks associated with bed sore include infection and even death. When bed sore develops, the drug therapy also included appropriate nutrition, including vitamin C, protein and zinc supplements that decrease bacterial load and provide a pressure-free physiological environment for the wound to heal. For certain cases, specific beds may be suggested, patients need to learn to prevent sores themselves, and this is, of course, the only practicable economical way. In the beginning, patients should be helped to support themselves by lift, shift and relieve pain, and this recovery should be initiated as soon as possible until they are fully paralyzed in both arms. Avoiding shear force is equally important as avoiding direct pressure. Pressure-relieving techniques remain the framework for Bed sore's treatment and prevention. Doctors need to consider the various mechanisms by which bed sore are developed to choose from among the variety of available pressure relief tools and approaches. This review summarizes the latest development in the management of bed sore by new technologies.

### ACKNOWLEDGEMENT

Authors are thankful to JSS Academy of Higher Education and Research, Department of Pharmaceutics, Industrial Pharmacy, JSS College of Pharmacy, Mysuru-570015, Karnataka, India.

### Conflict of Interest

The authors declare that they have no conflict of

interest for this study.

### Funding Support

The authors declare that they have no funding support for this study.

### REFERENCES

- Adkins, R. H., Water, R. L., Kendall, K. 1988. The cost of pressure sores in the treatment of acute spinal cord injury. *American Spinal Injury Association Abstracts Digest*, 49.
- Agostini, J. V., Baker, D. I., Bogardus, R. S. T. 2001. Prevention of pressure ulcers in older patients. *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*, 301.
- Allman, R. M., Laprade, C. A., Noel, L. B., Walker, J. M., Moorer, C. A., Dear, M. R., Smith, C. R. 1986. Pressure sores among hospitalized patients. *Annals of Internal Medicine*, 105(3):337-342.
- Amlung, S. R., Miller, W. L., Bosley, L. M. 2001. The 1999 National Pressure Ulcer Prevalence Survey: A Benchmarking Approach. *Advances in Skin and Wound Care*, 14(6):297-301.
- Andersen, K. E., Jensen, O., Kvorning, S. A., Bach, E. 1982. Decubitus prophylaxis: a prospective trial on the efficiency of alternating-pressure air-mattresses and water-mattresses. *Acta Derm Venereol*, 63:227-230.
- Beckrich, K., Aronovitch, S. A. 1999. Hospital-acquired pressure ulcers: a comparison of costs in medical vs. surgical patients. *Nursing Economics*, 17(5).
- Bennett, R. G., Bellantoni, M. F., Ouslander, J. G. 1989. Air-Fluidized Bed Treatment of Nursing Home Patients with Pressure Sores. *Journal of the American Geriatrics Society*, 37(3):235-242.
- Bergert, F. W., Conrad, D., Ehrental, K., Fessler, J., Gross, J., Gundermann, K. 2009. Pharmacotherapy guidelines for the aged by family doctors for the use of family doctors: Part D Basic conditions supporting drug treatment. *Int J Clin Pharmacol Ther*, 47(5):289-302.
- Bergstrom, N., Braden, B., Boynton, P., Bruch, S. 1995. Using a research-based assessment scale in clinical practice. *The Nursing Clinics of North America*, 30(3):539-551.
- Burnell, A. W. 1969. Bed-Sore Control and a Multi-Purpose Mattress. *Medical Journal of Australia*, 2(19):958-960.
- Cichowitz, A., Pan, W. R., Ashton, M. 2009. The heel: anatomy, blood supply, and the pathophysiology of pressure ulcers. *Annals of plastic surgery*, 62(4):423-429.
- Desforges, J. F., Allman, R. M. 1989. Pressure Ulcers among the Elderly. *New England Journal of Medicine*, 320(13):850-853.
- Edwards, J. V., Goheen, S. C. 2011. *New developments in functional medical textiles and their mechanism of action. In: Functional Textiles for Improved Performance, Protection and Health.* Woodhead publishing.
- He, P., Zhao, J., Zhang, J., Li, B., Gou, Z., Gou, M., Li, X. 2018. Bioprinting of skin constructs for wound healing. *Burns Trauma*, 6(1).
- Houle, R. J. 1969. Evaluation of seat devices designed to prevent ischemic ulcers in paraplegic patients. *Archives of physical medicine and rehabilitation*, 50(10):587.
- Kanj, L. F., Van B. Wilking, S., Phillips, T. J. 1998. Continuing medical education: Pressure ulcers. *Journal of the American Academy of Dermatology*, 38(4):517-538.
- Murphy, S. V., Skardal, A., Atala, A. 2013. Evaluation of hydrogels for bio-printing applications. *Journal of Biomedical Materials Research Part A*, 101(1):272-284.
- Parish, L. C., Witkowski, J. A., Crissey, J. T. 2012. *The decubitus ulcer in clinical practice.* Springer Science and Business Media.
- Schimp, V. L., Worley, C., Brunello, S., Levenback, C. C., Wolf, J. K., Sun, C. C., Bodurka, D. C., Ramirez, P. T. 2004. Vacuum-assisted closure in the treatment of gynecologic oncology wound failures. *Gynecologic Oncology*, 92(2):586-591.
- Seiler, W. O., Stahelin, H. B. 1985. Decubitus ulcers: preventive techniques for the elderly patient. *Geriatrics*, 40(7):53-60.
- Singh, J., Sangwan, S., Singh, J., Siwach, R., Shukla, G. 2013. An open labeled study to evaluate efficacy and safety of ampuicare in patients with bedsore. *International Journal of Basic and Clinical Pharmacology*, 2(4):371.
- Soonthornkiti, S., Jearanaisilawong, P. 2013. Design of anti-bedsore hospital bed. *Journal of Research and Applications in Mechanical Engineering*, 1(4):15-20.
- Su, L. Y. 2014. Design of an Intelligent Bedsore Treatment System base on Lab View. *In Applied Mechanics and Materials*, 551:189-193.
- Yastrub, D. J. 2010. Pressure or pathology: distinguishing pressure ulcers from the Kennedy terminal ulcer. *Journal of Wound Ostomy and Continence Nursing*, 37(3):249-250.