

## Pressure sores - update 12 minutes talk

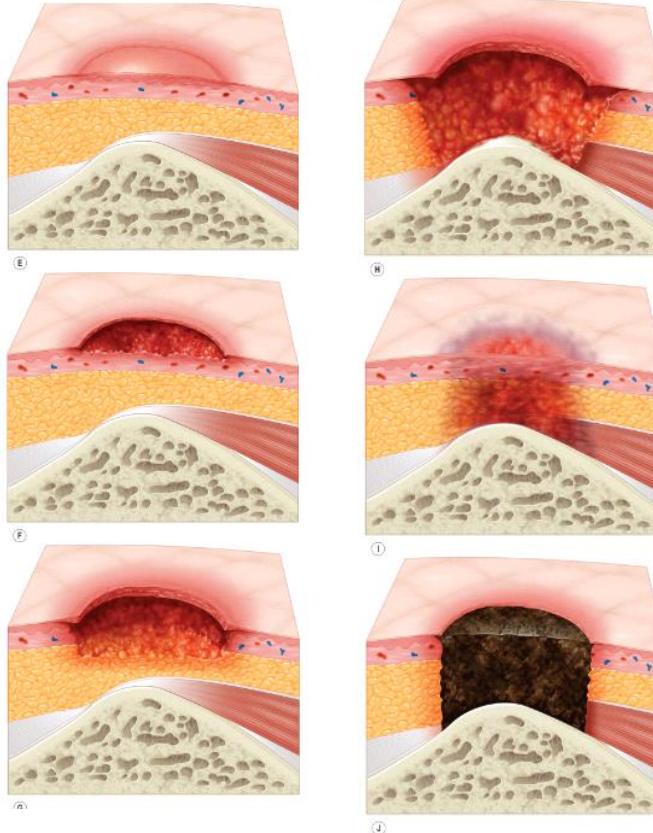
Prof. Jochanan Naschitz  
BeitBalev Nesher

- Routine and innovation
- Evidence/ wishful thinking
- Being practical

## Renamed “pressure injury”

- In April 2016, the National Pressure Ulcer Advisory Panel redefined pressure-induced skin and soft tissue lesions: the term “**pressure injury**” replaces the terms “pressure ulcer,” “decubitus ulcer,” and “bed sores.”
- Pressure injury develops
  - **typically over a bony prominence**, or
  - **associated with a medical device**
- **Skin can be intact or have an open ulcer.**
- Most pressure injuries develop during acute hospitalizations, in spite of the adoption of national pressure ulcer prevention guidelines.

## Six stages of skin and deep tissue injury

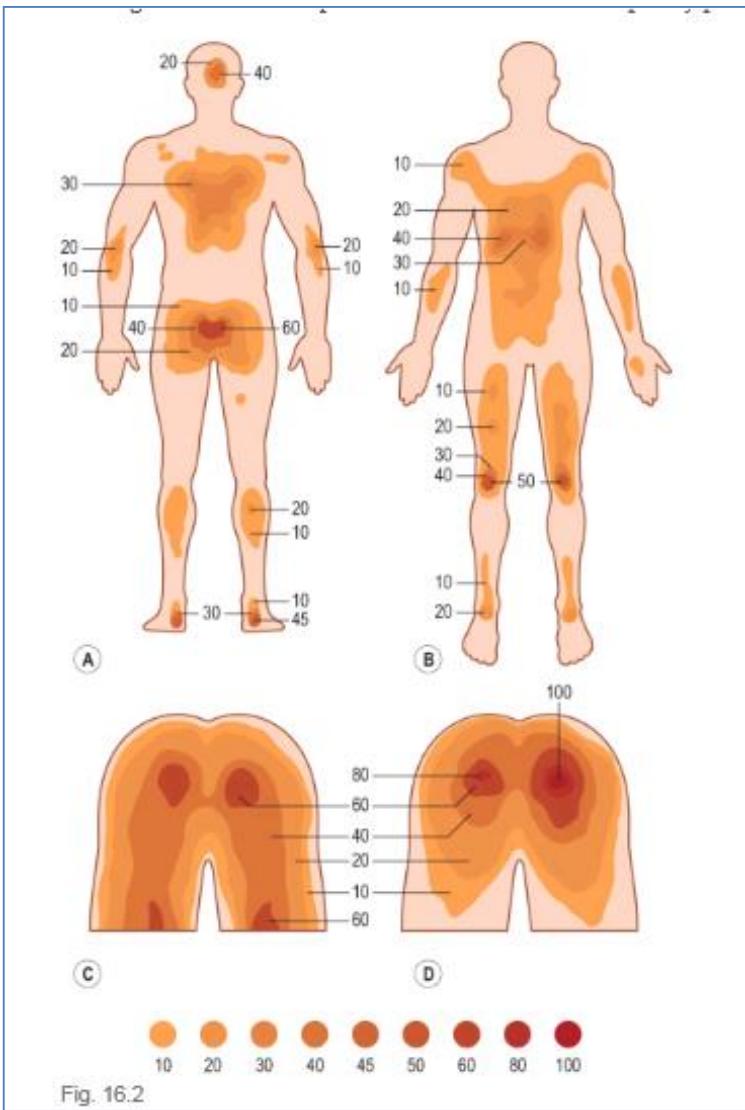


- **Stage 2** : Partial-thickness skin loss with exposed dermis, may also present as an intact or ruptured serum-filled blister.  
*Granulation tissue, slough, and eschar are not present.*



P.I. stage .....

## Pathogenesis - crushing the capillaries



The average **capillary closing pressure** is approximately **32 mmHg**

Distribution of pressure in a healthy adult male

- **(A)** supine,
- **(B)** prone,
- **(C)** sitting with feet hanging freely, and
- **(D)** sitting with feet supported. Values expressed in mmHg.
- (Adapted with permission from Lindan O, Greenway RM, Piazza JM. Pressure distribution on the surface of the human body I. Evaluation in lying and sitting positions using a "bed of springs and nails". *Arch Phys Med Rehabil*. 1965;46:378.)

## The ischemic concept challenged



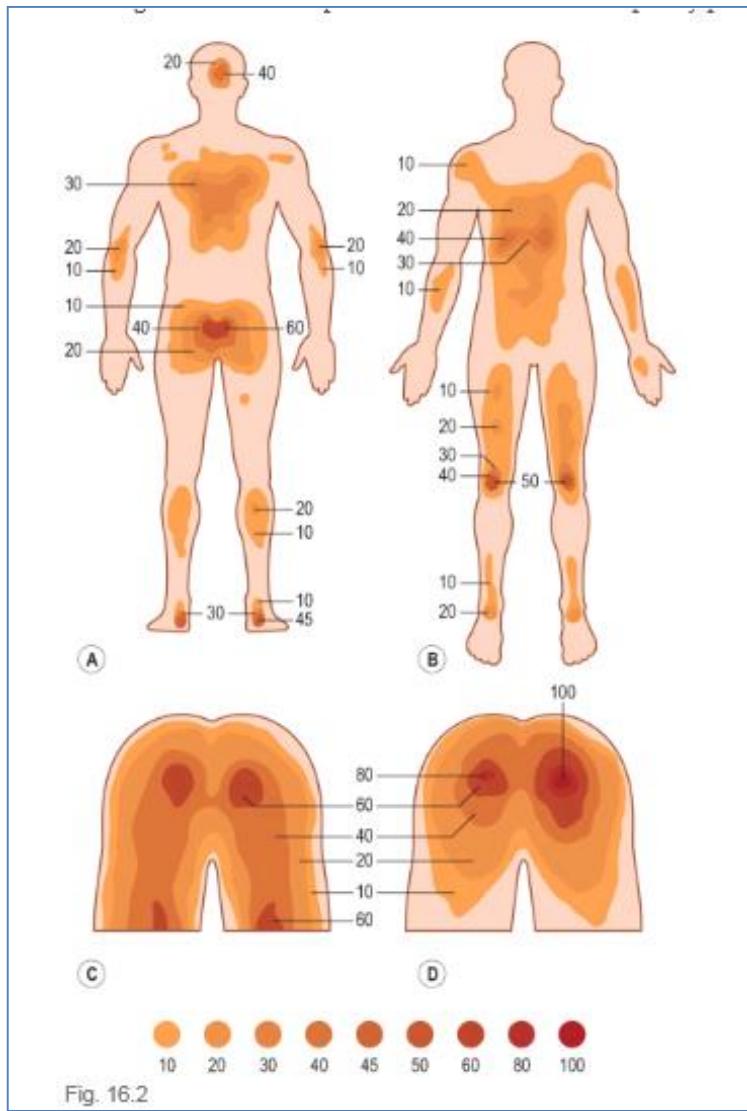


Fig. 16.2

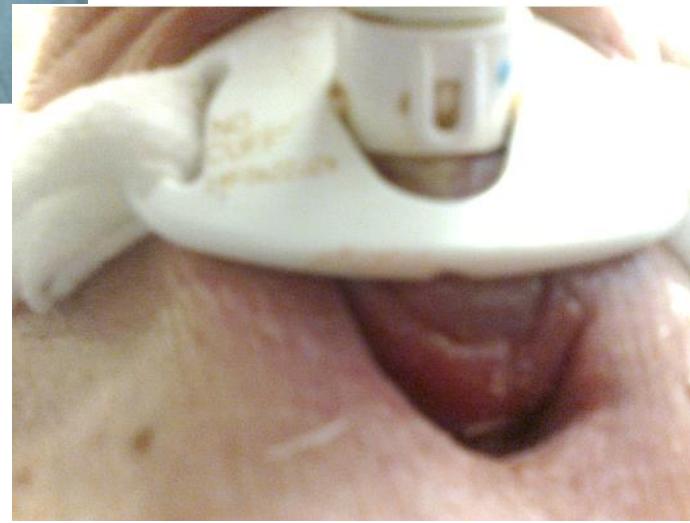




G. J.



gastrostomy



# Revision of the ischemic concept

- Based on MRI, digital fluorescent microscopy and computer simulations.

**Misconceptions identified**

- (1) Today we know that **capillaries in affected tissues stay at least partially open under any weight-bearing posture** ( Linder-Ganz and Gefen, 2007 ).
- (2) If those capillaries are occluded at pressures exceeding 32 mm Hg (referring to the Landis, 1930 paper) hypoxia develops **in the skin and subdermal tissues**.
- **Actually, grade 3 and 4 PIs develop from inside-outward**

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Clinical and biomechanical perspectives on pressure injury prevention research: The case of prophylactic dressings

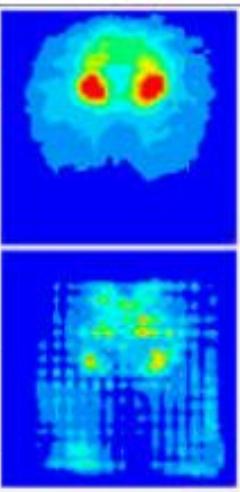
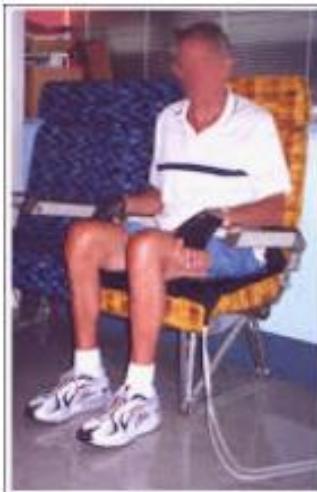
A. Gefen <sup>a,\*</sup>, J. Kottner <sup>b</sup>, N. Santamaria <sup>c</sup>

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<sup>c</sup> University of Melbourne & Royal Melbourne Hospital, Level 6, Alan Gilbert Building, University of Melbourne, Parkville, Victoria 3050, Australia

- (3) **Interface pressure measurements**, making sure that these interface pressures are below 32 mm Hg, is a misconception. **There is very weak correlation between interface pressures and internal tissue loads**
- Companies play the game of marketing despite that science indicates otherwise



Pressure Mapping Assessment f...



Matrix Based Tactile Force Sensor ...

However, there is very weak correlation between interface pressures and internal tissue loads

- (4) Now we know that: **due to the sustained tissue deformations** caused by the bodyweight the **cellular integrity is damaged first**,, leading to necrotic-apoptotic cell death.
- Ischemia and hypoxia are not the primary or direct cause of the injury.
- Ischemia adds to the severity, however that occurs several hours after the direct deformation damage has happened at the cellular level ( Oomens et al., 2015 ' Gefen and Weihs, 2016 ).
- (5) Today's understanding is to **reduce exposure to internal tissue deformations using prophylactic dressing**

## Pressure offloading



offloading

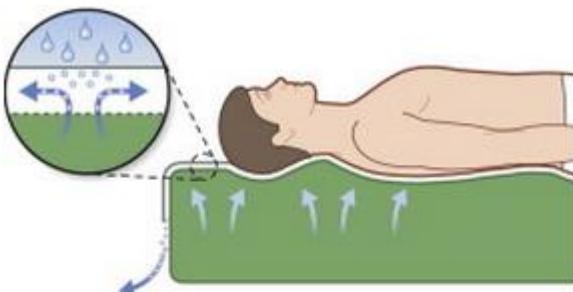
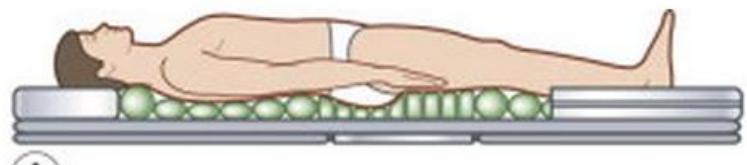
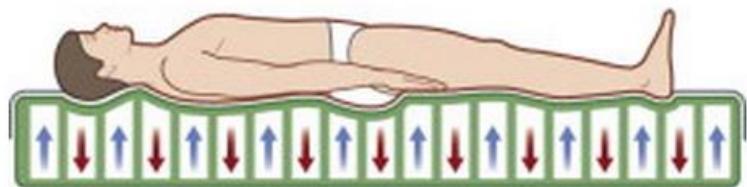


Fig. 16.8

Low air loss mattress concept.



(A)



(B)

Fig. 16.7

(A) Constant low-pressure surfaces seek to distribute pressure statically, while (B) alternating-pressure surfaces vary applied pressure over time.



Fig. 16.9

Fluidized bed.

## Air-fluidized beds

- a. Two RCTs found that use of air-fluidized beds contributed to the healing of a greater number of ulcers after 15 days compared with standard care.
- b. *Systematic review revealed no differences in rate of pressure ulcer healing with use of either alternating-pressure mattresses or low-air loss beds compared with standard care.*

## Pressure-relieving overlays

- a. One RCT demonstrated that a viscoelastic pad on the operating table significantly reduced incidence of postoperative pressure ulcers compared with a standard operating table.



Clinical and biomechanical perspectives on pressure injury prevention research: The case of prophylactic dressings

A. Gefen <sup>a,\*</sup>, J. Kottner <sup>b</sup>, N. Santamaria <sup>c</sup>

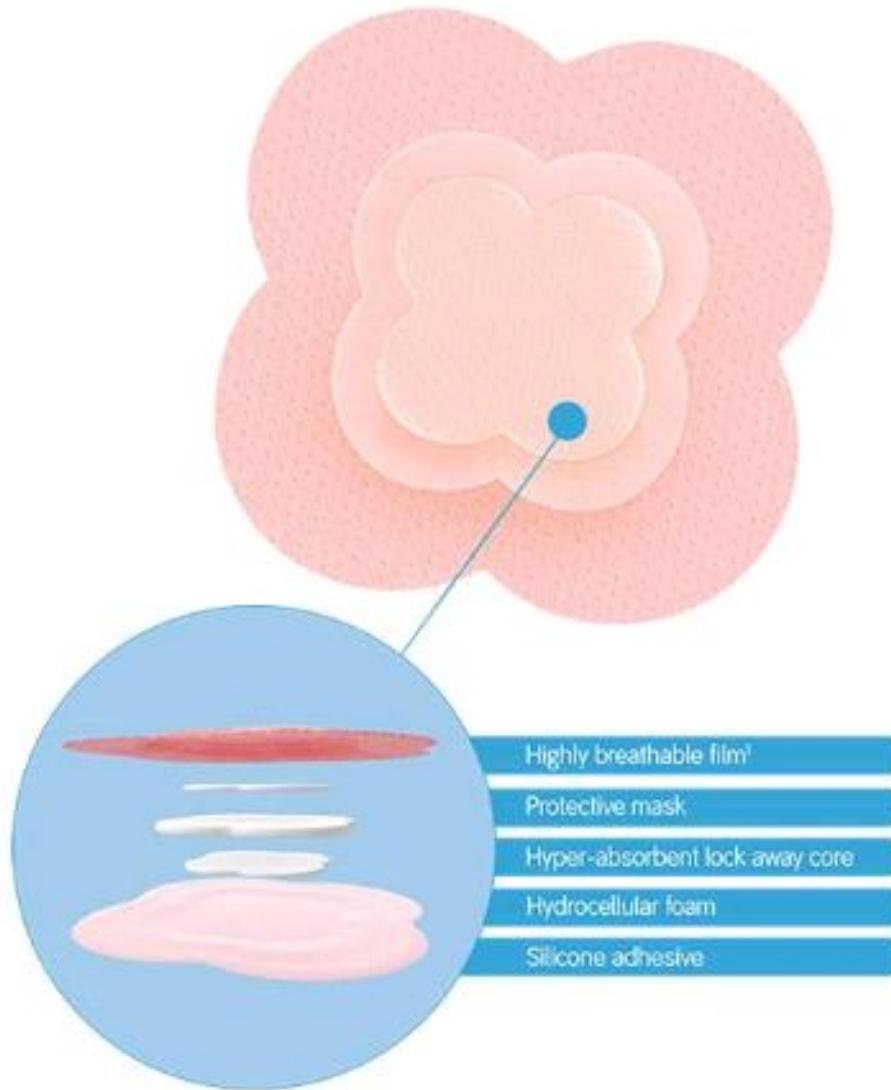
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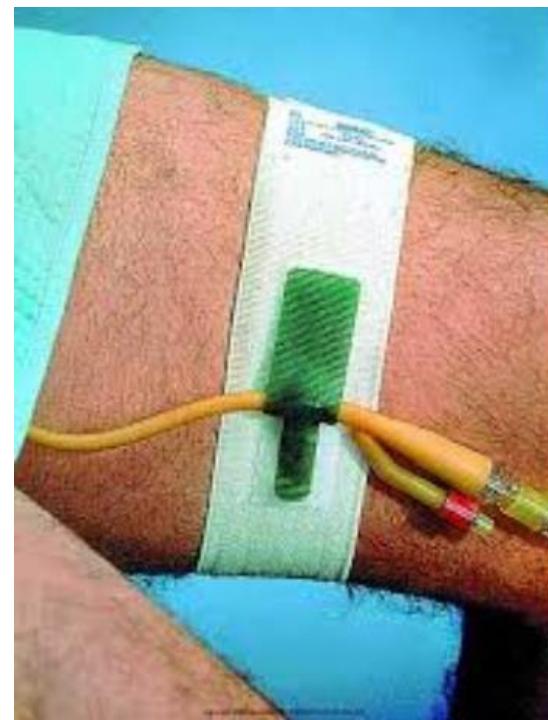
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## Prophylactic dressings to reduce tissue deformation

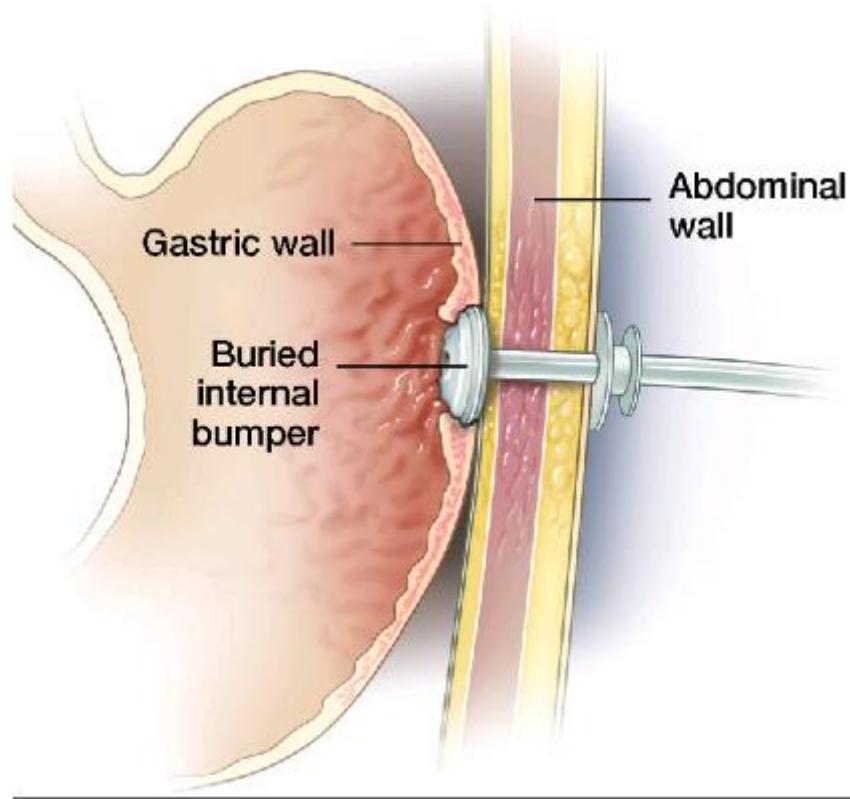
- The use of wound dressings as a potential additional protective means for the prevention of pressure injuries has been investigated intermittently over the past 20 years or more ( Clark et al., 2014; Black et al., 2015 ). The protective mechanisms underpinning the use of dressings to prevent pressure injuries is **through the reduction of tissue loading and internal deformations** by using the dressing as an interface between the patient and the support surface ( Levy et al., 2015 ).
- **Multilayer dressings essentially reduce deformations** in the underlying tissues by deforming in compression, tension and shear under weight-bearing, which cushions and protects the tissues ( Levy et al., 2015; Levy and Gefen, 2016 ).
- More recently, work by Brindle (2010) , Brindle and Wegelin (2012) in the U.S. provided early indications **that soft silicone multi-layer dressings** (the Mepilex® Border dressings by Molnlycke Healthcare AB, Sweden), used as prevention on the sacrum in critically ill patients, could significantly reduce the incidence of pressure injuries. Likewise, Chaiken (2012) reported a large study in 173 intensive care patients where she found a reduction in incidence of hospital-acquired sacral pressure injuries from a 13.6% baseline to only 1.8% within the 6 months of her prospective study; the dressing utilized in her work was again the Mepilex® Border Sacrum dressing. Santamaria et al. (2015a) built on this earlier work by conducting a large RCT using the same sacral dressings as well as the Mepilex®
-



## Device associated PI to be prevented



- Gastrostomy complicated: the buried bumper and syndrome



# Nutrition – guidelines are not matched by evidence

## Pressure Injury

Rebecca M. Wester MD  
Conn's Current Therapy 2018, 987-989

- limited evidence to guide **nutritional intervention** for treatment of pressure ulcers, but oral protein-calorie supplements associated with healing (**level 2 [mid-level] evidence**)

### Diet:

- **energy and protein requirements**
  - energy intake
    - 30-35 kcal/kg/day suggested by European Pressure Ulcer Advisory Panel
    - 35-40 kcal/kg/day if underweight or losing weight recommended by National Pressure Ulcer Advisory Panel
    - adjust energy intake based on
      - stage, number and size of wounds
      - age
      - clinical and nutrition status
      - comorbidities
  - protein intake to support wound healing
    - 1.25-1.5 g/kg/day recommended by Agency for Health Care Policy and Research
    - 1.2-1.5 g/kg/day recommended by National Pressure Ulcer Advisory Panel

However,

- **A 2014 Cochrane review concluded that there is no clear evidence that nutritional interventions (i.e., dietary supplementation) reduce the number of people who develop pressure injuries or help the healing of existing pressure injuries.**
- There is no evidence to support the use of vitamin C or zinc to treat pressure injuries in patients who are not deficient in these nutrients. There is no difference in healing rates associated with supratherapeutic doses of vitamin C or zinc.
- Surprisingly tube feedings increased the incidence of pressure injuries and was associated with poorer healing. Tube feeding is associated with agitation, increased use of physical and chemical restraints and worsening of ulcers in individuals with severe dementia.

Langer G, Fink A. Nutritional interventions for preventing and treating pressure ulcers. *Cochrane Database Syst Rev*. 2014;(6):CD003216.

## Abound (HMB, arginine, glutamine) - beneficial - with reservation

[Savas Sipahi](#),<sup>1</sup> [Ozkan Gungor](#),<sup>2</sup> [Mehmet Gunduz](#),<sup>3</sup> [Mehmet Cilci](#),<sup>4</sup> [Mustafa Cahit Demirci](#),<sup>4</sup> and [Ali Tamer](#). The effect of oral supplementation with a combination of beta-hydroxy-beta-methylbutyrate, arginine and glutamine on wound healing: a retrospective analysis of diabetic haemodialysis patients. *BMC Nephrol.* 2013; 14: 8 S

A total of **11 diabetic dialysis patients** were included in this **retrospective study** aiming to evaluate the effect of the diet support with beta-hydroxy-beta-methylbutyrate, arginine and glutamine on wound healing in diabetic dialysis patients. wound appearance were scored in accordance with the “Bates-Jensen” wound assessment tool. The results of 4-week treatment with beta-hydroxy-beta-methylbutyrate, arginine and glutamine (Abound®) support were evaluated in terms of wound healing.

**Conclusion** In conclusion, our findings revealed that Abound treatment makes a positive contribution to the **wound healing in diabetic dialysis patients**.

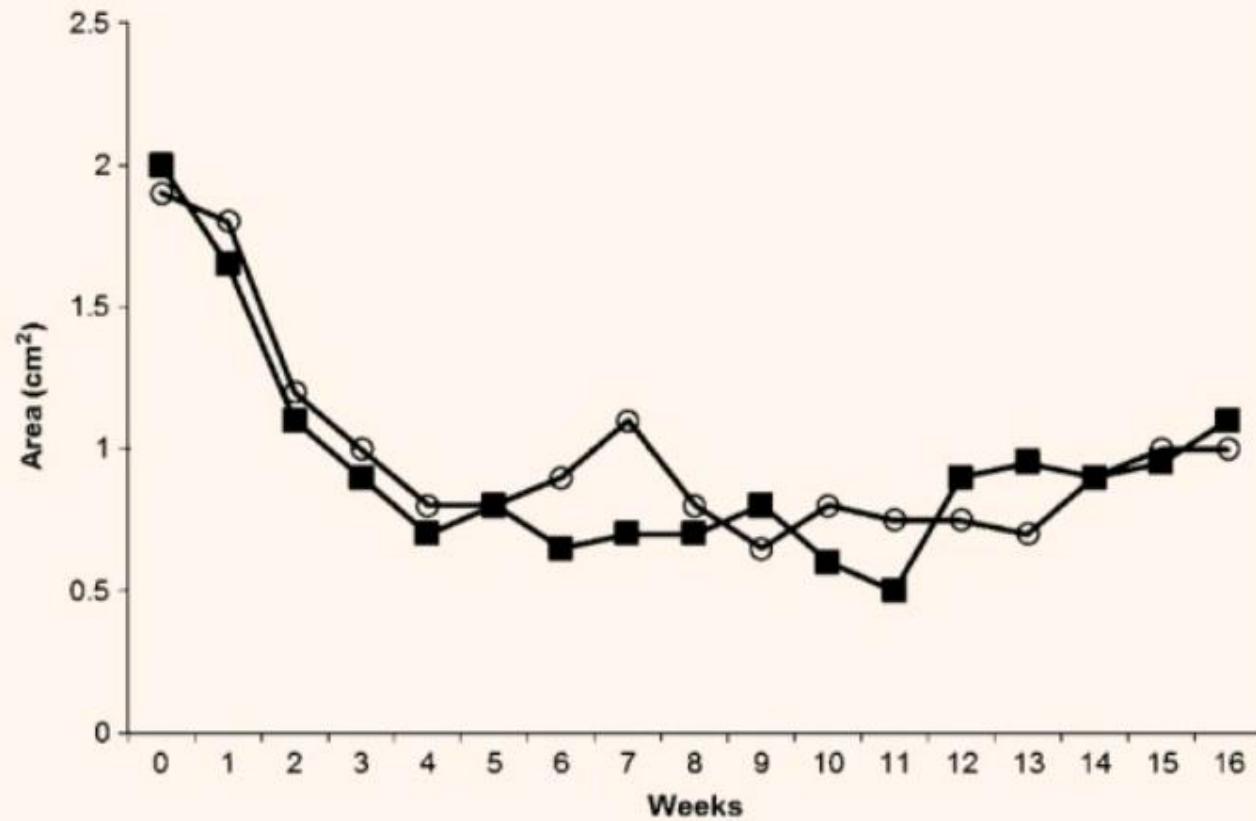
[Diabet Med.](#) 2014;31:1069-77.

**Effect of oral nutritional supplementation on wound healing in **diabetic foot ulcers**: a prospective randomized controlled trial.**

[Armstrong DG<sup>1</sup>](#), [Hanft JR](#), [Driver VR](#), [Smith AP](#), [Lazaro-Martinez JL](#), et al. Tucson, AZ.

- This manuscript constitutes, to our knowledge, the first multi-centre, multinational, randomized trial evaluating the potential efficacy of oral nutritional supplementation on wound healing in diabetes.
- Research has shown **that supplementation with arginine, glutamine and  $\beta$ -hydroxy- $\beta$ -methylbutyrate** may improve wound repair. This study tested whether such supplementation would improve healing of foot ulcers in persons with diabetes.
- **METHODS:** Along with standard of care, **270 subjects** received, in a double-blinded fashion, **(twice per day) either arginine, glutamine and  $\beta$ -hydroxy- $\beta$ -methylbutyrate or a control drink for 16 weeks. The proportion of subjects with total wound closure and time to complete healing** was assessed. The experimental drink (arginine, glutamine and  $\beta$ -hydroxy- $\beta$ -methylbutyrate) contained 79 kcal, 7 g l-arginine, 7 g l-glutamine and 1.5 g calcium  $\beta$ -hydroxy- $\beta$ -methylbutyrate (providing 1.2 g  $\beta$ -hydroxy- $\beta$ -methylbutyrate $\beta$ -hydroxy- $\beta$ -methylbutyrate) (Juven®/Abound®; Abbott Nutrition, Columbus, OH, USA). The control drink was a calorically similar (88 kcal), low glycaemic response supplement. Both products were identical in packaging
- **RESULTS: Those with low albumin or decreased limb perfusion in the supplementation group were 1.70 (95% CI 1.04-2.79) and 1.66 (95% CI 1.15-2.38) times more likely to heal.**
- Further investigation involving arginine, glutamine and  $\beta$ -hydroxy- $\beta$ -methylbutyrate in these high-risk subgroups might prove clinically valuable.

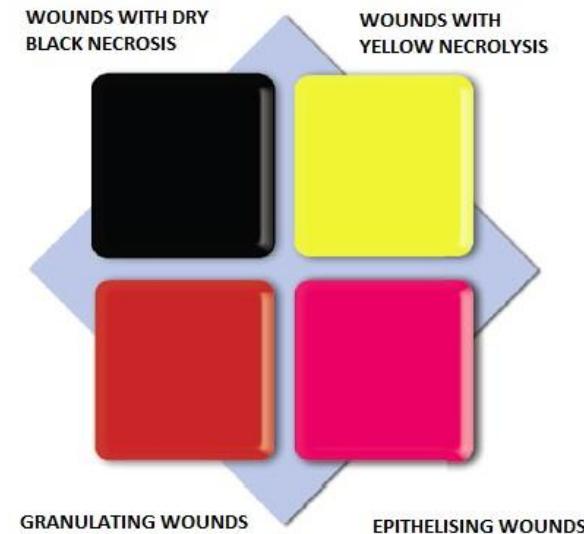
## diabetic foot ulcers: a prospective randomized controlled trial



Median wound area (cm<sup>2</sup>) by week; arginine, glutamine and  $\beta$ -hydroxy- $\beta$ -methylbutyrate supplementation (▪) ( $n = 129$ ) and Control (○) ( $n = 141$ ).

## PI - describe and document (in script an photograph)

- Site
- Stage ?
- Undermining, tunneling?
- Complicated ?



### The TIME concept:

- tissue,
- infection/inflammation,
- moisture balance
- edge of wound

## Debridement

- **Surgical (sharp):** Scalpel, scissors, or forceps to remove devitalized tissue; **quick and effective by skilled clinician**; should be used when infection is suspected; causes pain  
Sharp debridement is considered the most significant method in the prevention and control of biofilm.
- **Autolytic :** Synthetic dressing to allow the devitalized tissue to self-digest from the enzymes found in the ulcer fluids; recommended for those who cannot tolerate débridement; may take a long time to be effective; commonly used with palliative wounds
- **Enzymatic:** Topical débriding agent to dissolve the necrotic tissue; appropriate when there are no signs or symptoms of local infection
- **Biosurgery :** **Larvae** to digest devitalized tissue; quick and effective; good option **for those who cannot tolerate surgical débridement**; limited by access to larvae

## Dressings

- **Moist but not wet environment promotes** wound healing
- ! • **Dry wounds should be treated with moisture-promoting dressings, whereas exudative** wounds should be managed with absorptive dressings.
- ! • **Dry dressings should be avoided** because the debridement from removal of a fully dry dressing may impede healing and can cause significant pain.
- ! • A review of 51 studies (2947 participants) for the outcome of complete healing the PIs analysed the effectiveness of 13 dressings, 6 topical agents and 2 supplementary linking interventions. Most studies were small, with high risk of bias. As a whole, **it was not clear whether any treatment examined is more effective than saline gauze**

- Westby MJ<sup>1</sup>, Dumville JC, Soares MO, Stubbs N, Norman G. Dressings and topical agents for treating pressure ulcers. Cochrane Database Syst Rev. 2017;6:CD011947.
- Kroshinsky D, Strazzula L. Pressure ulcers. *Merk Manuals Professional Edition*. March 2013. <http://www.merckmanuals.com/professional/dermatologic-disorders/pressure-ulcers/pressure-ulcers/>. Accessed August 4, 2015
- Haesler E, ed. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: quick reference guide. Perth, Australia: Cambridge Media; 2014. <http://www.npuap.org/wp-content/uploads/2014/08/Quick-Reference-Guide-DIGITAL-NPUAP-EPUAP-PPPIA.pdf>

## Topicals

- Antibiofilm agents
- Honey
- Flaminal
- Growth factors
- Collagen filling

} no evidence-base of superiority

- Bellingeri A et al. J Wound Care 2016;25 (3).
- [Jull AB<sup>1</sup>](#), [Walker N](#), [Deshpande S](#). Honey as a topical treatment for wounds. [Cochrane Database Syst Rev](#). 2013 Feb 28;(2):CD005083
- [Jull AB](#), [Cullum N](#), [Dumville JC](#), [Westby MJ](#), [Deshpande S](#), [Walker N](#). Honey as a topical treatment for wounds. Honey as a topical treatment for wounds. [Cochrane Database Syst Rev](#). 2015;(3):CD005083.
- [Rashaan ZM](#), [Krijnen P](#), [van den Akker-van Marle ME](#) et al. **Clinical effectiveness, quality of life and cost-effectiveness of Flaminal® versus Flamazine® in the treatment of partial thickness burns: study protocol for a randomized controlled trial.** [Trials](#). 2016 Mar 5;17(1):122. doi: 10.1186/s13063-016-1240-5.
- Elodie Lefebvre, Christophe Vighetto, Patrick Di Martino, Veronique Larreta Garde, Damien Seyer. Synergistic antibiofilm efficacy of various commercial antiseptics, enzymes and EDTA: a study of *Pseudomonas aeruginosa* and *Staphylococcus aureus* biofilms. International Journal of Antimicrobial Agents 48 (2016) 181–188.
- [Hoeksema H<sup>1</sup>](#), [Vandekerckhove D](#), [Verbelen J](#), [Heyneman A](#), [Monstrey S](#). A comparative study of 1% silver sulphadiazine (Flammazine®) versus an enzyme alginogel (Flaminal®) in the treatment of partial thickness burns. [Burns](#). 2013 Sep;39(6):1234-41.
- [Westby MJ<sup>1</sup>](#), [Dumville JC](#), [Soares MO](#), [Stubbs N](#), [Norman G](#). Dressings and topical agents for treating pressure ulcers. [Cochrane Database Syst Rev](#). 2017;6:CD011947.

## VAC

[Cochrane Database Syst Rev.](#) 2015 May 20;(5):CD011334.

**Negative pressure wound therapy for treating pressure ulcers.**

[Dumville JC<sup>1</sup>](#), [Webster J](#), [Evans D](#), [Land L](#).

- **AUTHORS' CONCLUSIONS:** There is currently no rigorous RCT evidence available regarding the effects of NPWT compared with alternatives for the treatment of pressure ulcers.
- **High uncertainty remains about the potential benefits or harms, of using this treatment for pressure ulcer management**

## **Topical oxygen**

- Hyperbaric oxygen chamber in selected cases
- Topical (Natrox device) for ambulatory patients

NATROX is a class IIb medical device licensed under Medical Device Directive 93/42/EEC, which enables clinicians to prescribe pure humidified oxygen applied directly to a wound to assist wound healing in chronic or non-healing wounds (Figure 3).



The NATROX Oxygen Wound Therapy System comprises an oxygen generator (OG) and the oxygen delivery system (ODS). The device contains a small rechargeable battery that operates an oxygen concentrator, which generates 98% oxygen through the electrolysis of water that is naturally present in the atmosphere.

TABLE 2: Wound oxygen therapies compared (Tawfick and Sultan, 2012; Eggleton et al, 2015; Data on file, Inotec AMD Ltd)

	Hyperbaric oxygen therapy	Local perfusion via extremity chambers	Topical oxygen therapy: NATROX
Estimated local oxygen levels at wound during treatment* (mmHg)*	1800	800	650
Daily oxygen exposure (hours)	1.5	5	23
% of the week receiving therapy**	4	21	96

\*Calculated on the basis that 100% oxygen at 1 atmosphere = 760mmHg. \*\*Calculated on the basis of treatment occurring for 5 days/week for hyperbaric oxygen therapy and 7 days/week for the other oxygen treatment systems.

- A study evaluated topical oxygen therapy in patients with **chronic, non-healing wounds in a tertiary referral specialist clinic**. The mean wound duration before topical oxygen therapy was 15 months. In this previously non-healing group complete wound closure was observed in 32% of the total patients treated with the device. However, optimal wound healing occurred when the device was used for >25 days, with an 83% wound area reduction and 47% wound closure rate seen in venous leg ulcers and a 74% reduction and a 57% wound closure rate in arterial foot ulcers.
- **There is also potential for the use for PIs but experience is scarce.**

[Kaufman H, Gurevich M, Tamir E, Keren E, Alexander L, Hayes P.](#) Topical oxygen therapy stimulates healing in difficult, chronic wounds: a tertiary centre experience. [Wound Care.](#) 2018;27:426-433.

- Fit → Potential candidates for reconstructive surgery
- Frail → Potential candidates for skin graft
- III
- Multimorbidity
- Disability – dependence
- End of life condition

Conservative treatment/amputation

Gluteus maximus–gluteal thigh flap. ( A ) V–Y s  
muscle). Flap advancement for sacral coverage  
maximus muscle). Flap advancement for sacral



## PI treatment in institutionalized older persons - what makes it different

- The chance of healing PIs greatly depends on the patient's general health and comorbidities (**the patient around the wound**).
- **The time to healing PI can exceed the patient's life expectancy.**
- The mean time to **healing PI stages III and IV in older adults living in the community was**

**UK study: 8 months;** the levels of frailty was not mentioned in this study but probably was less than in institutionalized elders.

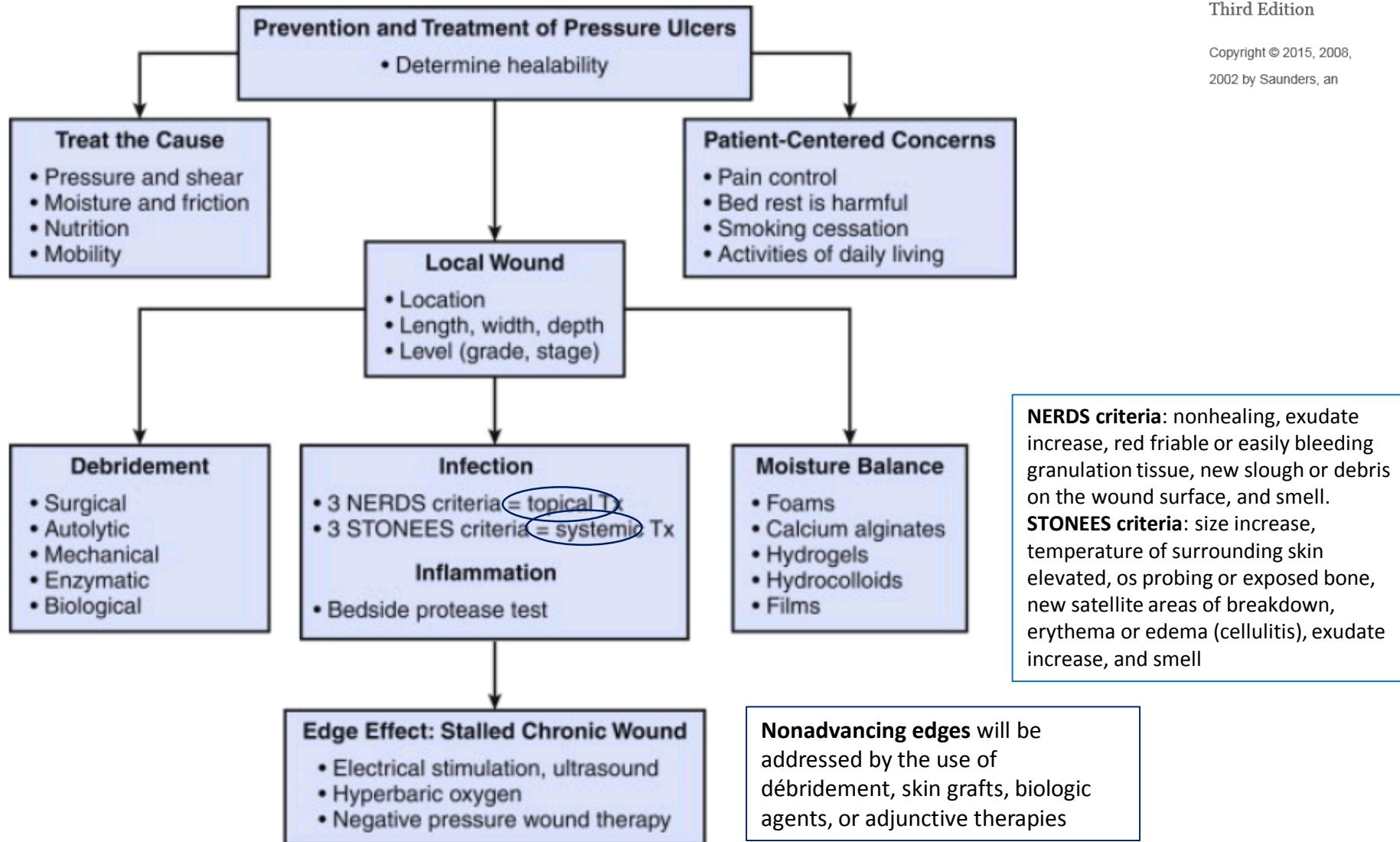
Guest JF, Fuller GW, Vowden P, et al. Cohort study evaluating pressure ulcer management in clinical practice in the UK following initial presentation in the community: costs and outcomes. *BMJ Open*. 2018;8:e021769

- **Lenient goals** for PI treatment might be appropriate in institutionalized older persons, similarly with the agreed lenient glycemic goals in diabetic patients and lenient blood pressure goals for hypertensives under similar circumstances and similar clinical settings
- Amputation may be required for failed surgical intervention or as a definitive first-line procedure in certain high-risk or poor prognosis patients .

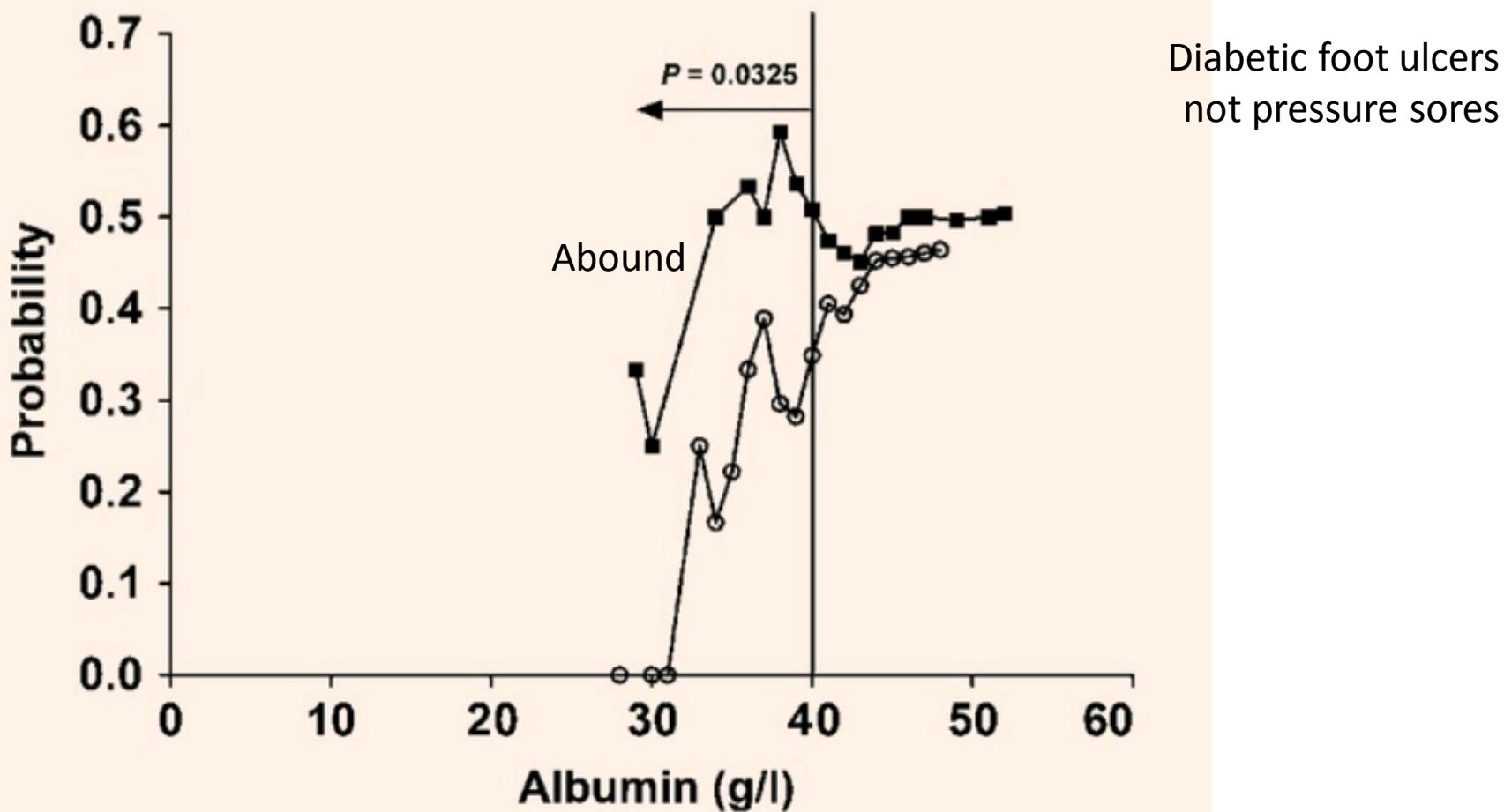
# Principles of management

Essentials of  
Physical  
Medicine and  
Rehabilitation  
Third Edition

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Cumulative probability of wound closure vs. albumin at entry by patient subgroups. Each point  $(x, y)$  represents the proportion,  $y$ , of subjects with total wound closure in the subgroup of subjects with baseline albumin  $\leq x$ . Specifically, for