

**CENTRO DE PREVENCION Y SALVAMENTO  
DEL PIE DIABETICO  
“ SAN ELIAN “**



**A new software-controlled voltage impulse generator  
(PBK ) as adjuvant in improving diabetic foot wound  
clinical conditions  
A presentation of 3 cases**

**Fermin Martínez De Jesus MD**

**Veracruz-Mexico**

# Background

Diabetic Foot it is a complex disease, where many variables interact continuously. Several treatment modalities are currently developing and under assessment. The use of tissue electrical stimulation is another newer field to be explored.







- **15 % of diabetic people will have an ulcer in their lifetime**
- **Diabete = leading cause of non-traumatic amputations (80 % of total)**
- **About 50 % can be prevented with a good lower extremities skin care**
- **The cost for the sanitary system is impressive**
  - (USA \$ 5 billion/year,
  - in Italy 25 % of the cost of a patient)

**Every 30 seconds a  
leg is lost to  
diabetes somewhere  
in the world.**

**Lancet – novembre 2005**

# The Lancet

The Lancet is keen to help draw attention to the enormity of the global burden of diabetic foot disease, and to support the efforts of those working to lessen the suffering and cost which result from this neglected problem. For this reason, the theme of *The Lancet* on Nov 12—to coincide with World Diabetes Day—will be on the foot in diabetes and related aspects of wound healing.

THE LANCET.com

Early Online Publication | [The Lancet](#) | [The Lancet Neurology](#) | [The Lancet Oncology](#)

Journal's Article Collections Authors Jobs & Conferences

Current Issue | [The Lancet](#), Current Issue, Volume 365, Number 9242, 30 Sept 2005

Back Issues | Editorial Comment | Articles | Mechanisms of D

Special Issues | [World Report](#) | [Diabetes Foot](#) | [Diabetes](#) | [Correspondence](#)

FAST TRACK

← previous article

Log in | Free Registration | Premium Content | Subscriptions | Email Alerts

DOI:10.1016/S0140-6736(05)66437-9

### World Diabetes Day: footing the bill

William Jeffman and Karl Bakker

that one major amputation is done somewhere in the world about every 30 s. For those who lose a leg, life never returns to normal. The patient often becomes

## World Diabetes Day: footing the bill

The worldwide prevalence of diabetes exceeds 200 million, which is projected to rise to over 300 million by the year 2030<sup>1</sup>. There is no cure and the condition can be devastating in its consequences. The aim of World Diabetes Day (on Nov 12) is to focus attention on the medical, the disease on health and the economy, but also to emphasise how the burden can be reduced. The spotlight for World Diabetes Day in 2005 falls on the foot.

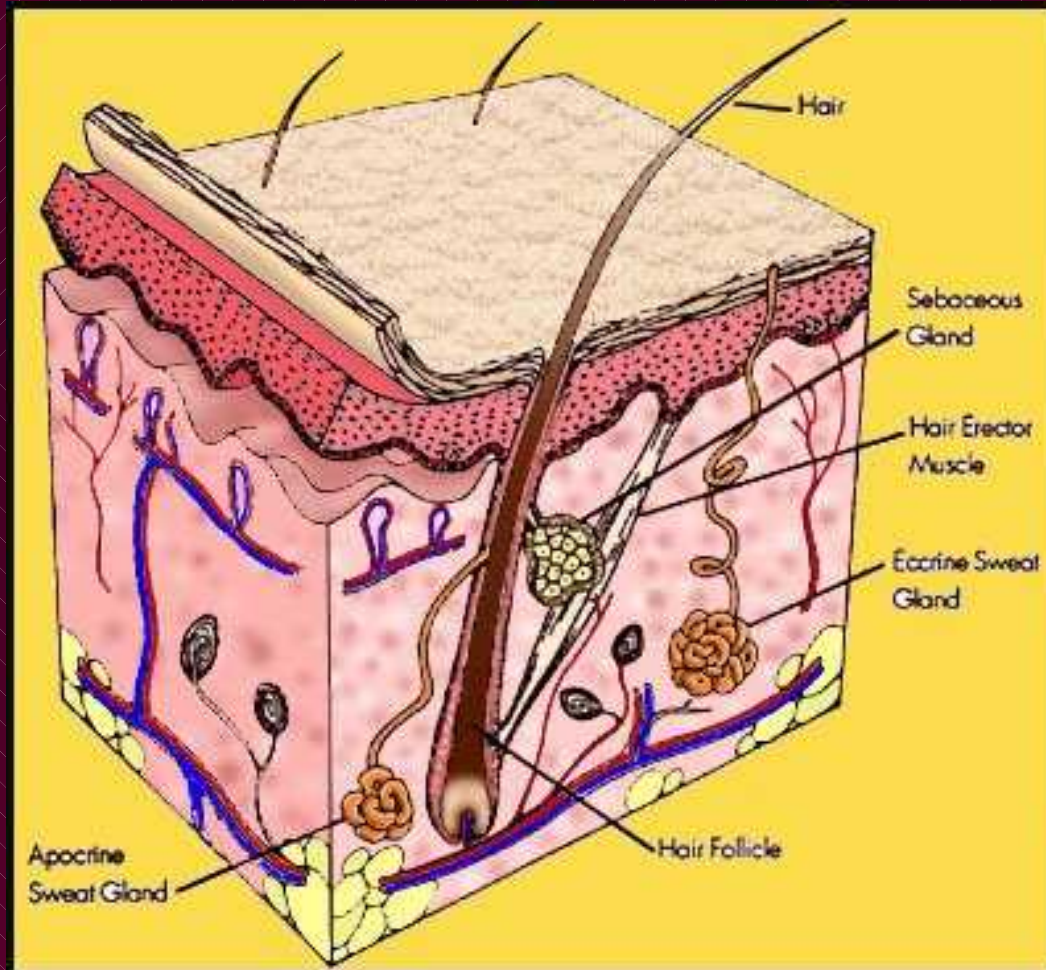
Diabetes of the foot ranks among the most feared complications of diabetes, and one of the most neglected. It is neglected partly because the pathogenesis is multifactorial and the presentation complex, and partly because doctors and nurses rarely receive formal training in the subject. Current management involves the



research papers—full articles or research abstracts on this theme. Details of the format can be found on the journal's Internet site. We are pleased to address the 50th Anniversary of the Lancet, and should like to hear from you. August 2005.

William Jeffman, Karl Bakker

# L'epidermide - struttura



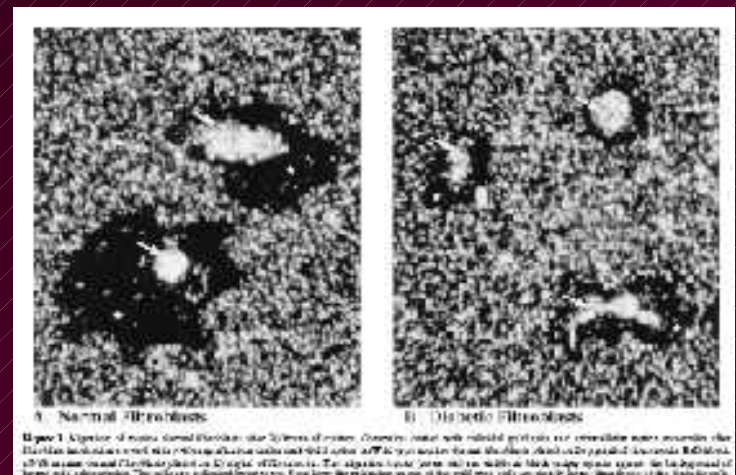
- **Mechanism of impaired function of skin is not fully understood**
- **In diabetes all the age-related changes of collagen appear to be accelerated**
- **Altered glycemc levels are affecting also skin functionality**

- **Among factors that lead to ulcers modification of skin capability to recover from minimal damages**
- **Minor small lesions are underestimated by the patient and very often by the physician**

- **glucose and some specific cells such as fibroblasts**
- **glucose affect cellular morphology of keratinocytes,**
- **high glucose concentrations inhibit keratinocytes proliferation.**
- **Keratinocytes cells with high glucose concentrations have decreased proliferation rate**
- **glucose was shown to inhibit proliferation in other cell types, including fibroblasts**

- human fibroblast in diabetic patients shown an impairment in migration,
- diabetes is accompanied by delayed wound healing and insufficient granulation tissue formation,
- Fibroblast derived chronic diabetic patients have lower proliferation

Lerman et al *AJP January 2003, Vol. 162, No. 1*

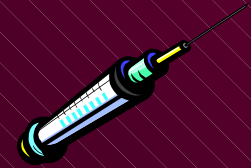


# A sample of typical ulcer



# Causes of foot ulceration and infection

- x Friction in ill fitting or new shoes
- x Untreated callous - Self treated callus
- x Foot injuries (ex, unnoticed trauma in shoes or when walking barefoot)
- x Burns (for example, excessively hot bath, hot water bottle, hot radiators, hot sand on holiday)
- x Corn plaster
- x Nail infections (paronychia)
- x Heel friction in patients confined to bed
- x Foot deformities ( hammer toe, Charcot's foot)

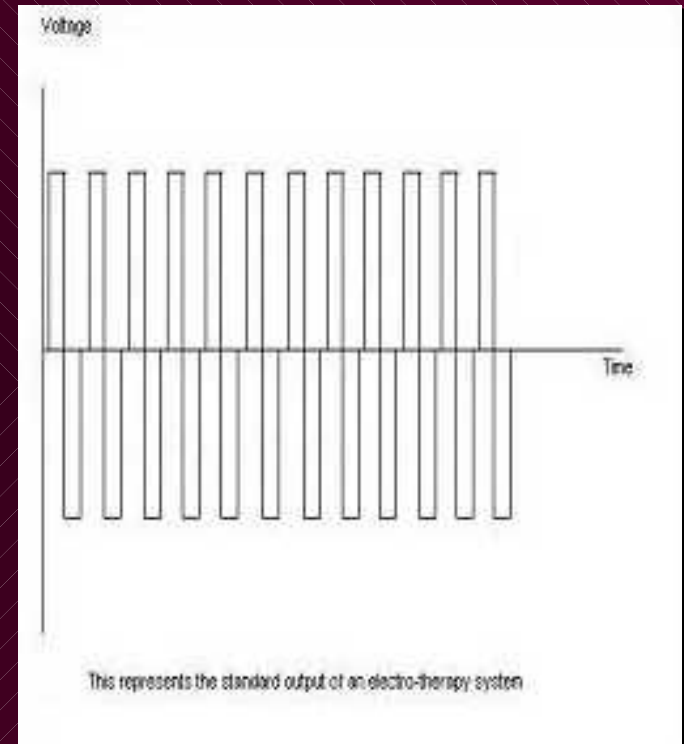


# Current Clinical Uses of PBK Therapy

- Pain relief
- Spasms or muscular damage
- Arthritis
- Neuropathic pain
- Vascular pathologies
- Back pain

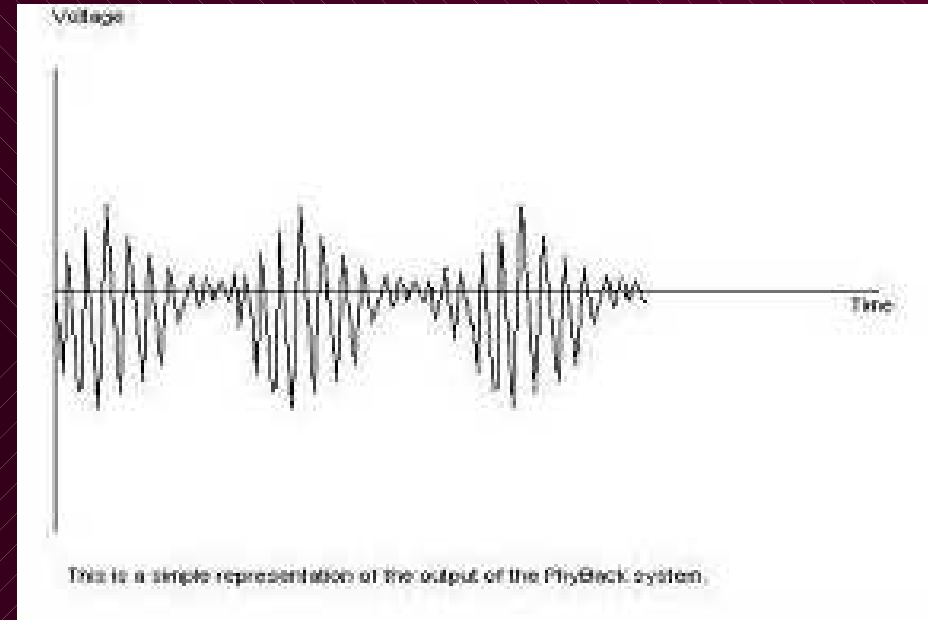
# Standard Electro-therapy Systems

- Use galvanic or faradic currents
- Square waves in a simple manner OF-ON
- Useful for short term pain control or
- Relaxing muscles



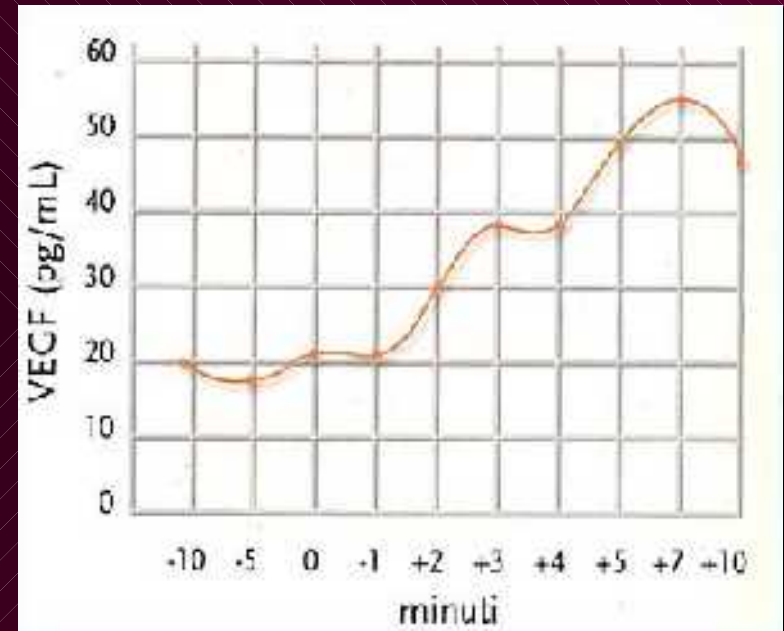
# PBK System

- Does not use current
- Extremely short volts impulses
- Billionths of a second
- Timing and power



# PBK effects

- Cell and tissue alarm status
- Local release of  $TNF\alpha$  &  $IL-B1$
- Local release of VEGF & increase of NO



# In Brief

## ■ Standard Electro-therapy

1. *Relaxes muscle*
2. *Removes pain for a short time*

## PBK Therapy

1. *Relaxes muscle*
2. *Stimulates VEGF*  
*Dilates vessels – more blood flow*
3. *Grows new vessels*
3. *Stimulates anti-inflammatories which reduces pain immediately*
4. *Attacks **the cause of the pain**, not just the symptoms*
5. *Removes pain for a long time*
6. *Improves muscle strength, mobility and flexibility*

# Background

## A In Vivo Journal published paper

- Ferroni P, Roselli M, Martini F, et al. Biological effects of a software-controlled Voltage Pulse Generator (PhyBack PBK-2C) on the Release of Vascular Endothelial Growth Factor. *In vivo* 2005;19:949-958.
- Debreceni L, Gyulai M, Debreceni A, Szabo K. Results of transcutaneous electrical stimulation (TES) in cure of lower extremity arterial disease. *Angiology* 1995;46:613-8.



# Ethics

- Because there is no reported side effects with the use of controlled electrical stimulation (PBK), and there is published basic research showing a release of VEGF and good proinflammatory response. We start to use PBK in some selected patients within a comprehensive care in our center.

# Objective

- To explore if PBK play a role as adjuvant therapy for improving the diabetic foot wound conditions.

## **Case 1**

**Patient out of treatment for vascular dystrophic digit ulcers with improvement of wound healing conditions after digit amputation with the use of PBK**



CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIÁN

# Patient General Data

**Patient:** FFG

**Age:** 67 years

**BMI:** 22.14 kg/m<sup>2</sup>

**Family History:** Chronic liver diseases (+), ischemic heart diseases (+).

**Years of diabetes duration:** 30 yrs

## **Oral Antidiabetics**

- Metformine/Glybenclamide 500/5 mg / 8 h



CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIAN



## Initial Assessment

- Fasting glycemia: 155 mg/dL
- Cholesterol: 161 mg/dL
- Tryglicerides: 135 mg/dL
- HbAlc1: 7.3 %
- EKG: cardiac arrithmya



# Initial Assessment

Tampico Grading : B1 (ischemia)

Wagner: 2

Fontaine: Grade IV

ABI: Right Foot: 0.54 Left: 0.63 (Moderate-severe bilateral ischemia)

TBI : non palpable digit pulses

Reydel- Sieffer : R 5 L 4.

Michigan: R: 8 pts L: 7 pts

Cardiff: No Odor



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



## Wound Care Protocol

- **PEDIS Infection and Tampico Quick Grading**
- **DF San Elian Grading & Score**
- **Confirmed Ischemia**
- **Debridement of necrotic tissue and abscess**
- **NpHSS wound cleanse**
- **Antibiotics**
  - Empirical polymicrobial coverage (mono or triple)
  - Fixed by cultures
  - MRSA
  - Ambulatory
- **Silver ions dressings or Hi Tech dressings**
- **Maintaining body homeostasis**



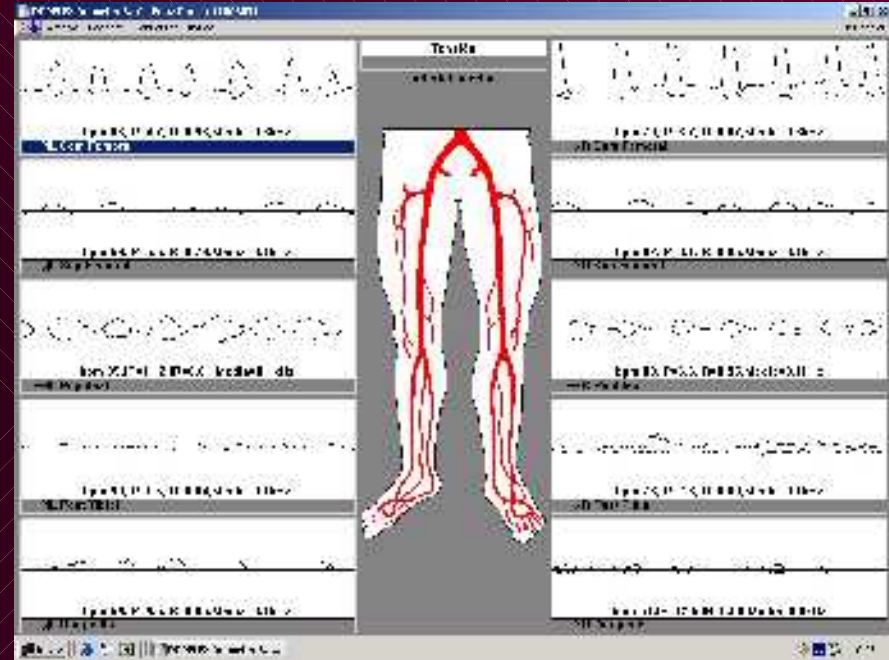
1 week



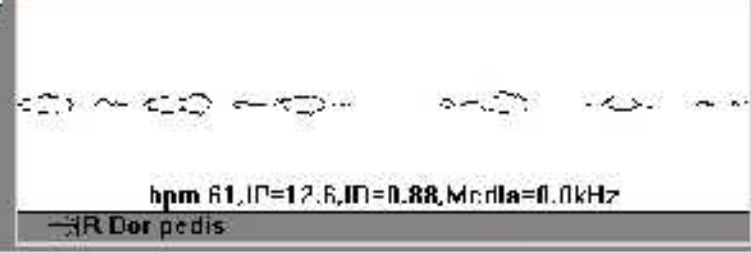
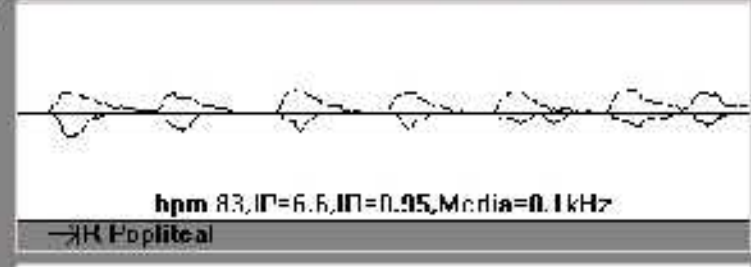
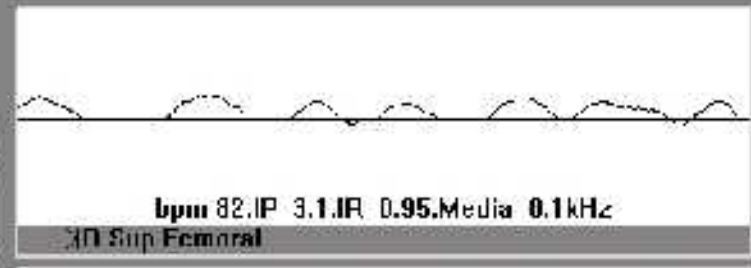
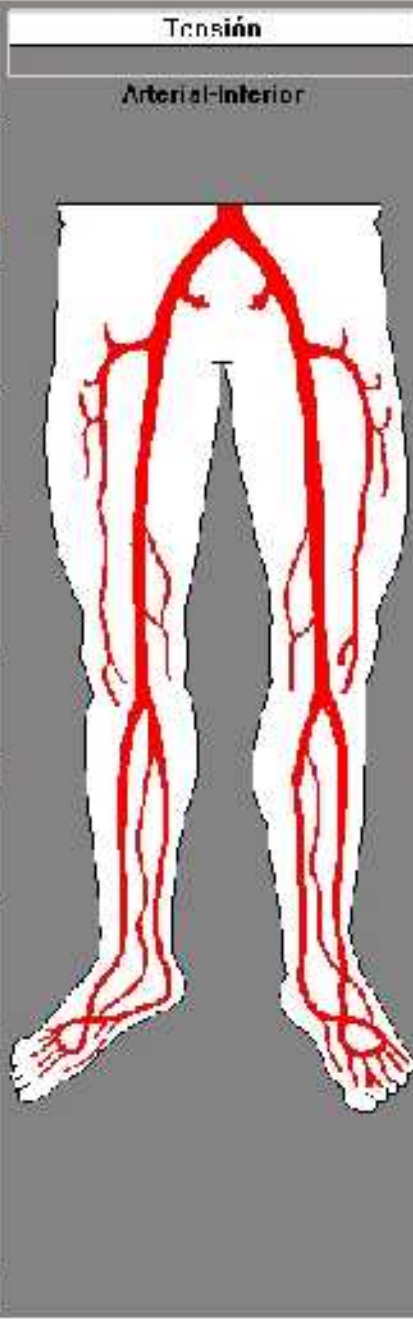
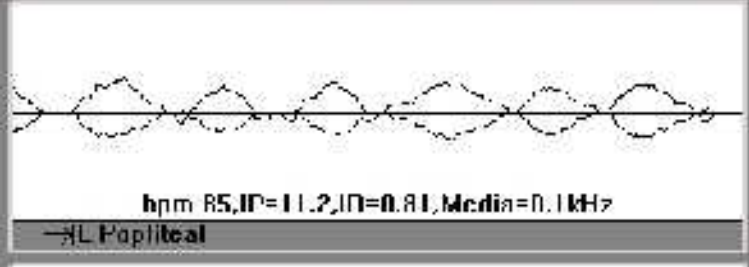
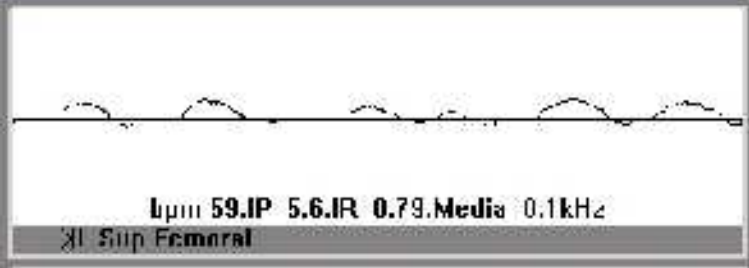
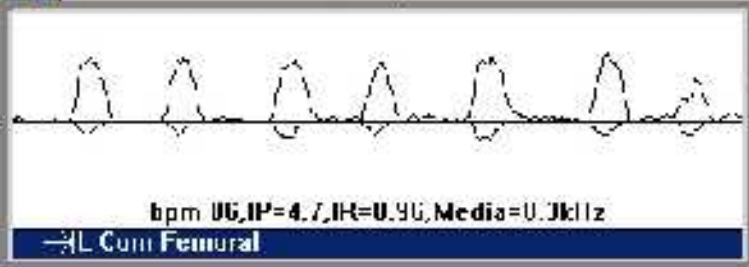
CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN

16 March 2007

Vascular Assessment confirmed critical  
ischemia with obstruction up to femoral  
superficial arteries



Critical Ischemia Left Leg

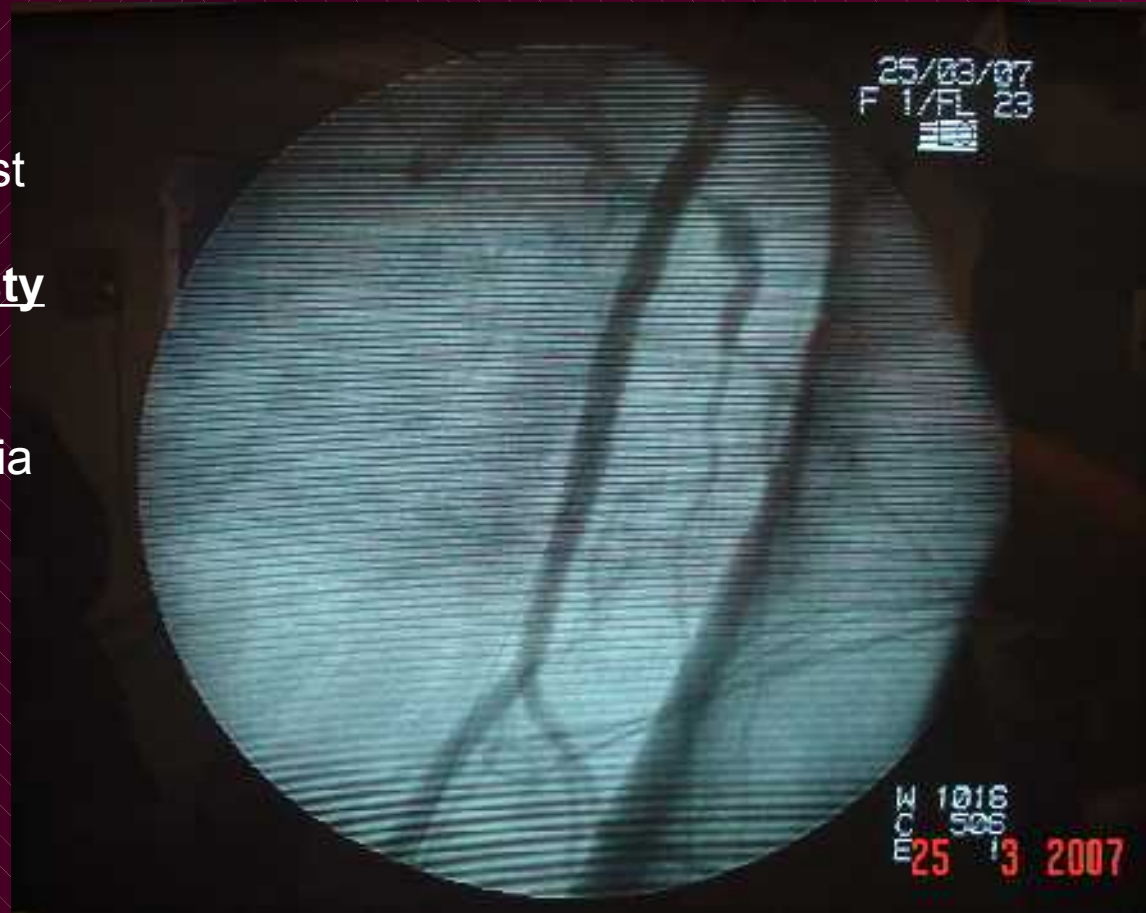




CENTRO DE PREVENCION Y SALVAMENTO

DE PIE DIABETICO SAN ELIAN

Vascular surgeon and Angiologist submitted the patient to a failed **Endovascular distal angioplasty** on March 25/ 2007, due to total obstruction at the punctured femoral site and cardiac arrhythmia and hemodynamic decompensation during the anesthetic procedure.





18 3

PROF. DR. N. Y. BİLİR  
RUMELI HEMİRAJYENİ  
VE FAKÜLTESİ  
RUMELI HEMİRAJYENİ  
VE FAKÜLTESİ  
RUMELI HEMİRAJYENİ  
VE FAKÜLTESİ



CENTRO DE PREVENCION Y SALVAMENTO  
-----  
DE PIE DIABETICO SAN ELIAN

**Patient continues protocol of wound  
care and starts the first PBK phase**





CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIÁN



02 04 2007





CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIÁN

PBK Phase 3



26 04 2007



# Amputation of 3rd right toe





CENTRO DE PREVENCION Y SALVAMENTO

DE PIE DIABETICO SAN ELIAN

**BACTERIAL CULTURE**

*Pseudomonas aeruginosa*

Resistant STRAIN TO ALL

ANTIBIOTIC



18-05-07

# Foot Bucket NpHSS immersion





CENTRO DE PREVENCION Y SALVAMENTO

DE PIE DIABETICO SAN ELIAN

## Week 1 PROMOGRAM



## Week 2 PROMOGRAM



Lazaro-Martinez JL, Garcia ME, Beneit MJV, Martinez-De Jesus FR, et al.  
Randomized comparative trial of a collagen-oxidized regenerated cellulose dressing  
In the treatment of neuropathic diabetic foot ulcers. Cir Esp 2007;82:27-31.



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



Week 3 PROMOGRAM





CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIÁN

25-06-07

Almost total wound closure





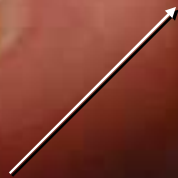
**Amputation bed in final  
epithelization phase**



Remember  
Patient has severe and critical  
Leg ischemia unsuccessfully  
treated

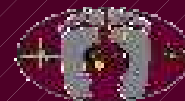
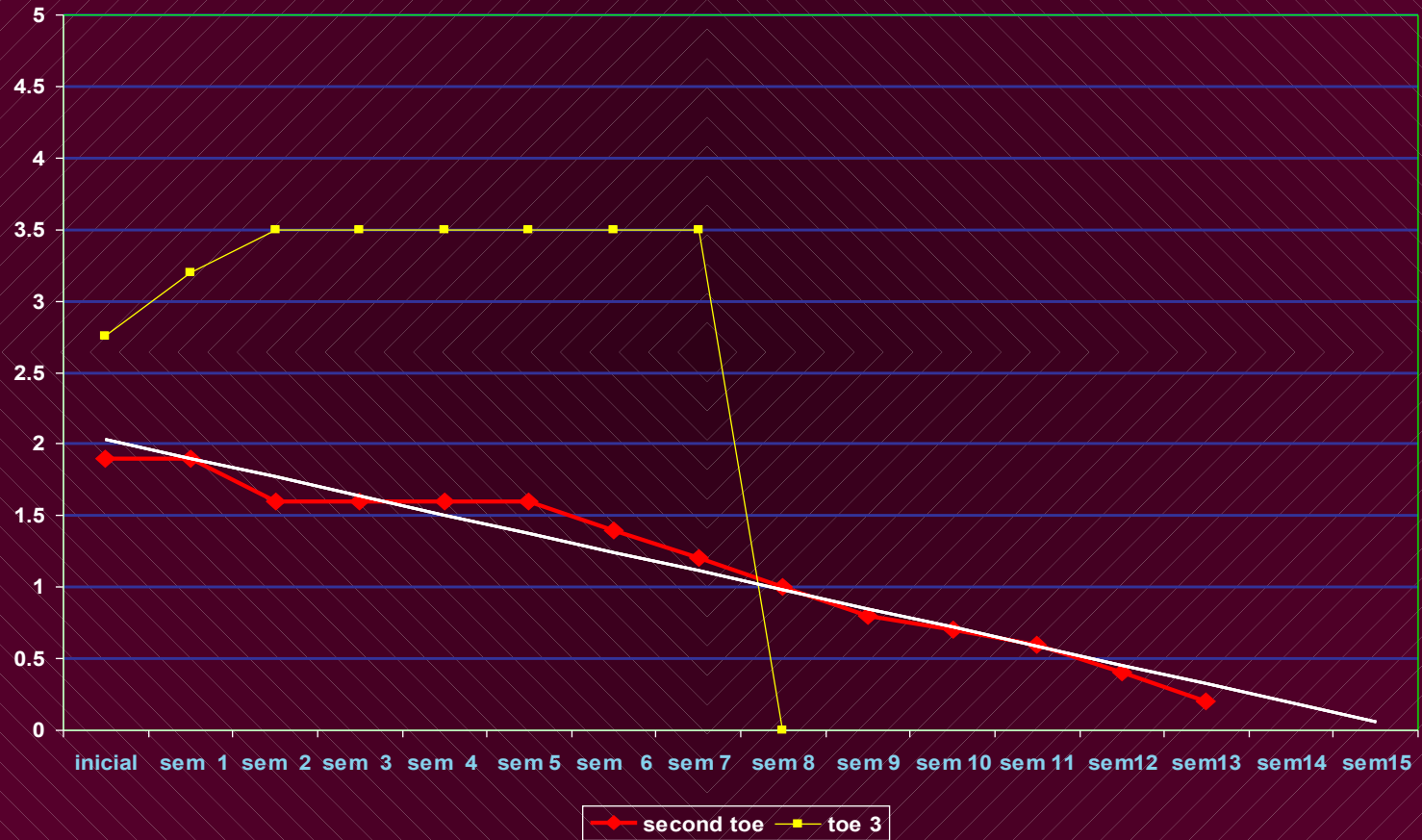


**Vascular dystrophic ulcer almost healed**



06/07/07

# Wound healing trend



## Case 2

# Osteomyelitis and severe metatarsal and digit infection



CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIAN

# PATIENT GENERAL DATA

**Patient:** PCC

**Age:** 73 years

**Years of diabetes duration:** 23 years

**HbA1c:** 13.2%

**Usual treatment:** NPH Insuline 30 UI fasting and 15 UI by noon.

**Started PBK :** 30 Mar 2007



CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIAN

# Physical Findings

**Tampico Grading:** C2

**Wagner:** 2

**Fontaine:** Grade I

**ABI:** R Foot: 1.42      Left: 1.0

**Toe BI :** 1.14 (97%)

**Reydel- Sieiffer :** 0 Righth      0 Left

**Michigan:** 11 score righth      12 score left foot

**Cardiff Odour Scale:** No odour



**(06-03-2007)**

**HAlc1: 13.2 %**

**Fasting Glycemia: 309 mg/dL**

**Cholesterol: 209 mg/dL**

**Tryglicerides: > 500 mg/dL**

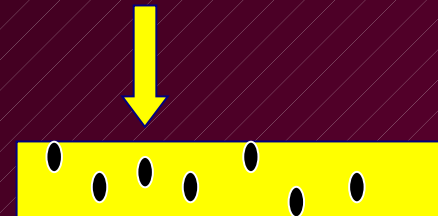
**(27-03-2007)**

**Hb: 9.6 g/dL Hto: 29.4% Leu: 15.8**

**Fasting glycemiae: 99 mg/dL Col: 110 mg/dL Tg: 105 mg/dL**

**Wound Culture: Staphylococcus epidermidis, Pseudomonas aeruginosa (Rifampicina)**





**Initial  
Inspection**



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIAN



**Initial Wound "toe  
sausage" (Osteomyelitis)**



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELÍAN



14/03/2007

# Wound Care Protocol

- **PEDIS Infection and Tampico Quick Grading**
- **DF San Elian Grading & Score**
- **Confirm or rule out Ischemia**
- **Debridement of necrotic tissue and abscess**
- **NpHSS wound cleanse**
- **Antibiotics**
  - Empirical polimicrobial coverage (mono or triple)
  - Fixed by cultures
  - MRSA
  - Ambulatory
- **Silver ions dressings or Hi Tech dressings**
- **Maintaining body homeostasis**



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



Flap necrosis 2nd. Toe amputation



3rd toe gangrene

Plantar erythema



After amputation PBK started in order to improve wound zone conditions



3rd toe amputation



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIAN



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIAN

# PBK

<b>Phase</b>	<b>Start</b>	<b>End</b>
<b>I</b>	30-03-07	3-04-07
<b>II</b>	05-04-07	19-04-07
<b>III</b>	23-04-07	08-05-07
<b>IV</b>	9 -05-07	13 -05-07



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIÁN



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIÁN













## **Case 3**

# **First ray improvement of delayed wound healing conditions with the use of PBK**



CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIAN

## Patient Data

**Patient: JLB**

**Age: 68 years**

**BMI: 23.15 Kg/m<sup>2</sup>**

**Years of diabetes duration: 11yrs**

**Antidiabetic**

Oral Metformine

850mg 1 tablet/every 8hr





## Initial Assessment 19 Apr 2007

- Fasting glycemia: 194 mg/dL
- HbA1c: 9.9 %
- Mean of previous fasting glycemia: 200mg/dl
  
- Cholesterol: 198 mg/dL
- Tryiglicerides: 239 mg/dL
  
- EKG: Normal



# Wound characteristics and grading

**DF Tampico Grading C3**

**Wagner : 2**

**ABI: R: 1.6 (Monckenberg )**

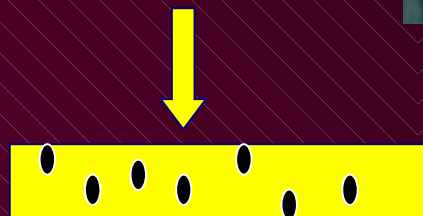
**L: 1.16 (Normal)**

**Toe/BI: 0.96 (97%)**

**Reydel- Sieiffer : D: 3 I: 4**

**Michigan: R 11, L:13.**

**Cardiff: No Odor**





## Wound Care Protocol

- **PEDIS Infection and Tampico Quick Grading**
- **DF San Elian Grading & Score**
- **Ruled out Ischemia**
- **Debridement of necrotic tissue and abscess**
- **NpHSS wound cleanse**
- **Antibiotics**
  - Empirical polimicrobial coverage (mono or triple)
  - Fixed by cultures
  - MRSA
  - Ambulatory
- **Silver ions dressings or Hi Tech dressings**
- **Maintaining body homeostasis**





CENTRO DE PREVENCION Y SALVAMENTO

DE PIE DIABETICO SAN ELIAN



Week 1 after BLUE SKY negative pressure system

PROMOGRAM dressing started



Wound changes after promogram (week 2)



CENTRO DE PREVENCION Y SALVAMENTO  
-----  
DE PIE DIABETICO SAN ELIAN

## PBK TREATMENT PHASES DATE

- May 05- May 10 1st Phase
- May 12 – May 24 2nd Phase
- May 27 & May 30 3th Phase
- Jun 4 & 8 4th Phase





CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



10 May 07

■ Week 2nd with high tech dressings  
( Promogram )

■ Glycemic control achivied: 91mg/dl



PBK PHASE 1





CENTRO DE PREVENCIÓN Y SALVAMENTO

DE PIE DIABÉTICO SAN ELIAN



17 mayo 07

*Fasting Glucose 100mg/dl*



Week 3 with Promogram

PBK PHASE 2



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



24 Mayo 07

**FG: 119 mg/dL**



31 Mayo 07

**FG: 122 mg/dL**





**FG: 111 mg/dL**



**7 Junio 07**

End PBK treatment



13 Jun 2007



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN

# Epifast Kertinocytes skin cultures





CENTRO DE PREVENCIÓN Y SALVAMENTO  
-----  
DE PIE DIABÉTICO SAN ELIAN



13-06-08



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIÁN



**epifast®**

**ALO injerto de epidermis humana cultivada in vitro**  
**EQUIVALENTE DE PIEL HUMANA VIVA**

- Libre de HIV-1, HIV-2 y CMV
- Acelera la reepitelización
- Reduce en un 50% el tiempo de recuperación
- Libera factores de crecimiento
- Estimula la proliferación de las células del paciente
- Reduce el dolor y las infecciones
- Evita la deshidratación

56 cm<sup>2</sup>  
**PRODUCTO ESTERIL**  
**NO SE GARANTIZA LA ESTERILIDAD**

**Vida para su piel**

**BIOSKINCO**  
TEC. S.A. DE C.V.

**BIOSKINCO S.A DE C.V**  
Reg. 0009405506 SSA  
Cuadra Iquique 886, 306, 2706

**DOMICILIOS**  
En la Cd. de México:  
Av. Juárez 40-200  
Reparación de Cda. México  
Tlalcoyotlán, Edo. de México  
64000 México

**TELEFONOS**  
En la Cd. de México:  
+52 (055) 5365-4764 / 718  
Número gratuitos:  
01 800 122 1000



CENTRO DE PREVENCION Y SALVAMENTO  
DE PIE DIABETICO SAN ELIAN



Epifast week 1



CENTRO DE PREVENCION Y SALVAMENTO

DE PIE DIABETICO SAN ELIAN



0 1 2 3 4 5 6 7 8 9



**SAN ELIAN**  
CENTRO DE PREVENCION Y  
SALVAMENTO DE PIE DIABETICO  
VERACRUZ-MEXICO  
Orizaba No. 198 Col. I. Zaragoza Tel: (271)

Paciente: Jain  
Fecha: 02

Week 3 Epifast

02-07-07



CENTRO DE PREVENCIÓN Y SALVAMENTO  
DE PIE DIABÉTICO SAN ELIAN



Week 3 Epifast



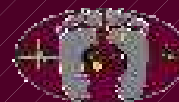
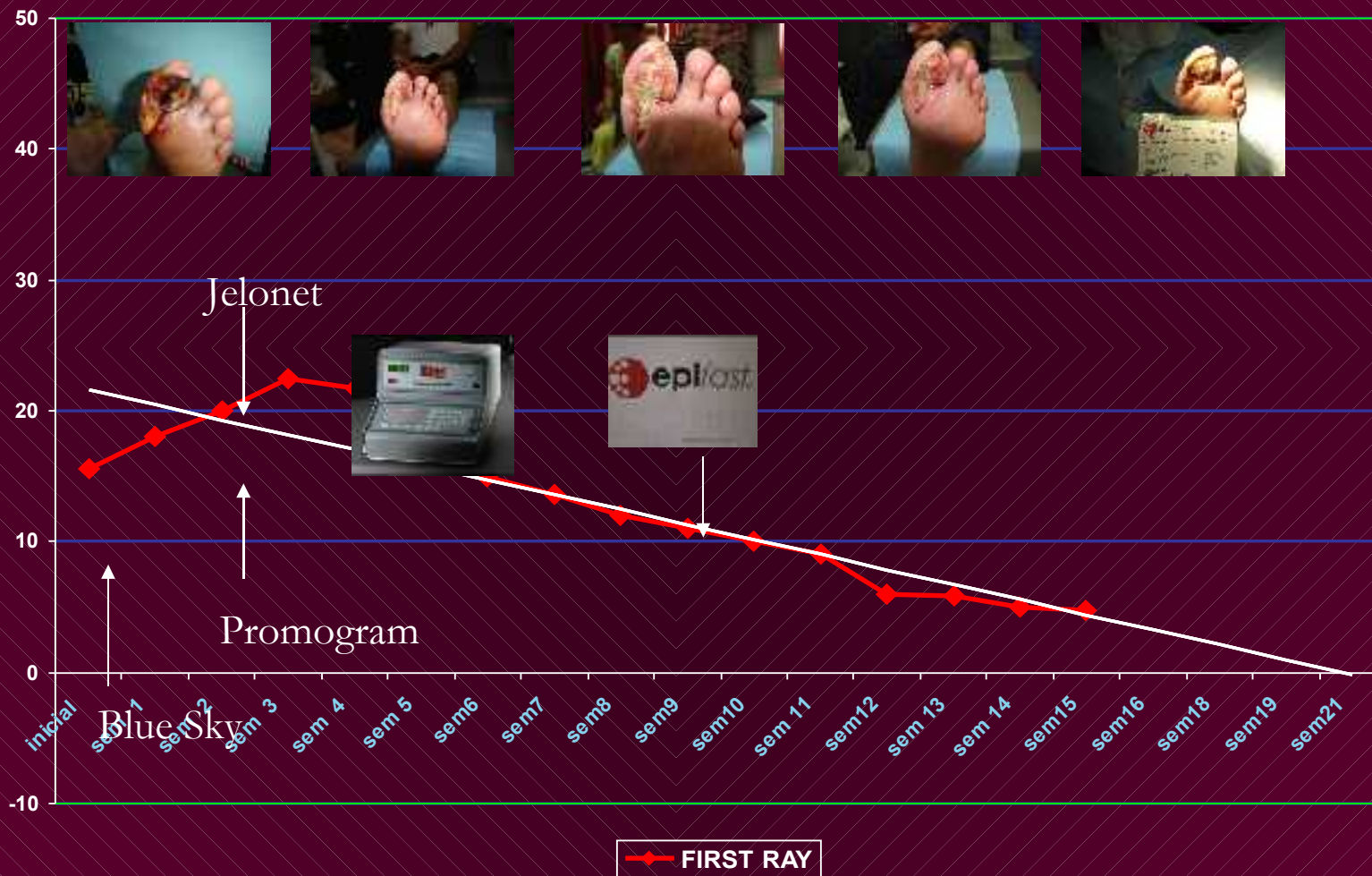
Week 4 Epifast



CENTRO DE PREVENCION Y SALVAMENTO  
-----  
DE PIE DIABETICO SAN ELIAN



# Trend of patient wound healing



# Conclusion

**PBK appears to play a role as adjuvant therapy in improving the wound conditions mediating inflammatory response and increasing VEGF**

**Clinical trials are being performed to increase the evidence level of these promissory preliminary findings**

