



# Ozonized autohemotherapy, a new method to treat dairy cow acute interdigital phlegmon. Comparison with ceftiofur and oxytetracycline

Paolo Scrollavezza<sup>1</sup>, Francesco Ansaloni<sup>1</sup>, Paolo Polidori<sup>1</sup>,  
Marco Ablondi<sup>2</sup>, Bruno Pogliacani<sup>2</sup>

<sup>1</sup> Dipartimento di Scienze Veterinarie. Università di Camerino (MC), Italy.

<sup>2</sup> Doctor of Veterinary Medicine, private employee.

*Corresponding author:* Prof. Paolo Scrollavezza. Dipartimento di Scienze Veterinarie, Università di Camerino. Via Circonvallazione 93/95, 62024 Matelica (MC), Italy - Tel. +39-0737-789356 - Fax: +39-0737-789213 - Email: paolo.scrollavezza@unicam.it

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## ABSTRACT

To determine whether ozone (a powerful germicidal agent) administered by autohemotherapy would be useful for treatment of acute interdigital phlegmon (foot rot) in dairy cows, 60 animals affected by clinical signs of foot rot were used in this trial. Twenty dairy cows were assigned to one of the three treatment groups: ceftiofur sodium 1.0 mg/kg Body Weight (B.W.) i.v. every 12 h; oxytetracycline 6.0 mg/kg B.W. i.v. every 24 h; ozone 60 mg in 1000 ml of blood by i.v. autohemotherapy every 24 h. Treatments stopped when animals were no longer lame. All the lameness stopped after three days of ceftiofur treatment, three days of oxytetracycline treatment and one day of ozone autohemotherapy treatment. Use of ozone in autohemotherapy for dairy cow foot rot was as effective as ceftiofur and oxytetracycline treatments, and resulted to be the best one because milk and meat obtained from dairy cows treated with ozone were not subject to withdrawal time.

*Key words:* Ozone therapy, Dairy cows, Interdigital phlegmon, Foot rot.

## RIASSUNTO

**AUTOEMOTERAPIA OZONIZZATA, UN NUOVO PROCEDIMENTO PER TRATTARE IL FLEMMONE INTERDIGITALE NELLA BOVINA DA LATTE: COMPARAZIONE CON CEFTIOFUR E OSSITETRACICLINA.**

*In questo studio sperimentale sono state utilizzate 60 vacche da latte affette da sintomi clinici del flemmone interdigitale acuto, con lo scopo di verificare se l'ozono (un potente agente germicida) somministrato via autoemoterapia potesse costituire un valido trattamento per la cura del flemmone. Le vacche sono state suddivise in tre gruppi sperimentali costituiti da 20 animali ciascuno, ai quali venivano somministrati i seguenti trattamenti: 1,0 mg/kg P.V. di sodio-ceftiofur intravena ogni 12 h; 6,0 mg/kg P.V. di ossitetraciclina intravena ogni 24 h; 60 mg di ozono in 1.000 ml di sangue via autoemoterapia intravena ogni 24 h. I trattamenti venivano sospesi quando gli animali non mostravano più zoppie. Tutte le zoppie erano scomparse dopo tre giorni di trattamento con sodio-ceftiofur, tre giorni di trattamento con ossitetraciclina e un giorno di trattamento con ozono. L'uso dell'ozono per il trattamento del flemmone interdigitale è risultato efficace quanto quelli con sodio-ceftiofur e ossitetraciclina, ed è risultato inoltre essere il migliore in quanto il latte e la carne ottenuti dalle vacche da latte trattate con ozono non necessitavano del rispetto del tempo di sospensione, che è stato, rispettivamente, pari a tre giorni per il trattamento con ossitetraciclina, a 0,5 giorni per il trattamento con sodio-ceftiofur e a zero giorni per il trattamento con ozono.*

*Parole chiave:* Ozono-terapia, Vacche da latte, Flemmone interdigitale.

## Introduction

Acute Interdigital Phlegmon (Foot rot, Necrotic pododermatitis, Foul foot) is an infectious disease, which starts as a wound infection between the toes. It is characterized by lameness, swelling, and fever. The affected cow often will refuse to eat and will have a drastic decrease in milk production. The area between the toes often will be open and release a foul smelling fluid. The bacterium *Fusobacterium necrophorum* has been reported to cause foot rot. However, researchers have not been able to reproduce typical foot rot lesions with this organism. A previous research conducted at the University of Nebraska (Hudson, 1982) indicates that a combination of *Fusobacterium necrophorum* and *Bacteroides melaninogenicus* are the predominant bacteria isolated from foot rot. When mixtures of these two bacteria were applied to the broken skin of the foot or injected into the tissue between the toes, typical lesions of foot rot were reproduced. Both bacteria were re-isolated from the experimentally-induced lesions. Other organisms commonly isolated from animals with foot rot include *strep-*

*tococci*, *staphylococci*, *corynebacterium*, and various fungi, all of which are common in our environment, especially in presence of high humidity. Cuts, bruises, puncture wounds, or severe abrasions permit these bacteria to enter the tissue of the foot where they start an infection (Guard, 1995). Foot rot is a leading cause of economic loss to the dairy producer. In fact, current research indicates that in many herds, losses due to lameness (Foot rot and Digital dermatitis) exceed those due to clinical mastitis (Guard, 1997). Early Foot rot treatment is necessary to prevent animals from incurring chronic problems. The treatment is with systemic antibiotics. Oxytetracycline chloridrate and ceftiofur usually work better if treatment is started early (Morck *et al.*, 1998).

Ozone is a powerful germicidal. Its potent germicidal activity is doubtless due to its oxidizing power, and it has been extensively employed for the sterilization of public water supplies, for the treatment of wounds in hospitals, and for various purposes of sterilization (Viebahn-Hansler, 1991). Moreover, ozone demonstrated a great effectiveness in the healing of patients suffering by fungine infections (Menendez, 1990).

Table 1. Number and day of treatments in different cow groups.

Treated cows	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ceftiofur treatment (n.)	3	3	4	2	3	3	2	3	2	4	4	4	4	3	3	2	3	2	2	4
Ceftiofur treatment (d)	1.5	1.5	2	1	1.5	1.5	1	1.5	1	2	2	2	2	1.5	1.5	1	1.5	1	1	2
Oxytetracycline treatment (n.)	4	3	3	2	4	5	2	2	2	2	4	3	3	4	2	2	3	3	4	3
Oxytetracycline treatment (d)	4	3	3	2	4	5	2	2	2	2	4	3	3	4	2	2	3	3	4	3
Ozone treatment (n.)*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ozone treatment (d)*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

\*  $P < 0.001$  when compared with ceftiofur and oxytetracycline groups.

Table 2. Depreciation and maintenance tool costs in different treatment groups (US\$ per cow).

Direct cost		Ceftiofur	Oxytetracycline	Ozonized autohemotherapy
Depreciation therapy tools (US\$)	a	0	0	0.75*
Maintenance therapy tools (US\$)	b	0	0	0.25**
Depreciation and maintenance total tool cost (US\$)	c	0 (a+b)	0 (a+b)	1.0 (a+b)

\*  $0.75 = (3000 / 4) / 1000$ , where 3000 is the ozone generator initial capital, 4 are the years of depreciation, 1000 is the annual ozone generator employment. To evaluate the instrumental capital depreciation cost we have considered 4 years of economic duration: after this period, the technological obsolescence imposes the substitution of the instrumental capital.

\*\*  $0.25 = (8\% \text{ of } 3000) / 1000$ ; 8% is the maintenance percentage. The cost maintenance amount (8% of the capital) derives from the observation of costs sustained during this experimentation and in other previous experiences.

Some previous experimental studies (Scrollavezza *et al.*, 1997a; Scrollavezza *et al.*, 1997b) reported efficacy of ozone autohemotherapy in bovine mastitis and metritis. One of the advantages of ozone therapy is that ozone has no withdrawal time: it does not leave a residue in milk and meat. An electric generator produces ozone for medical purposes.

The aims of this clinical trial are:

1. To compare the ozone used in autohemotherapy with oxytetracycline chloridrate and ceftiofur sodium in acute interdigital phlegmon.
2. To compare the ozone treatment costs (direct and indirect costs) with the antibiotic treatment costs.

## Material and methods

Sixty Holstein-Friesian dairy cows with an average of 30 l/d milk yield destined to transformation in Parmigiano-Reggiano cheese, and affected by acute interdigital phlegmon were equally assigned to 1 of the 3 treatment groups: ceftiofur sodium 1.0 mg/kg I.V. every 12 h; oxytetracycline chloridrate 6.0 mg/kg I.V. every 24 h; ozone 30 mg in 1000 ml of blood by I.V. autohemotherapy every 24 h. Ozone autohemotherapy was performed administering homologous 1.000

ml blood containing ozone 30 µg/ml: the instrument took about 3-4 min to ozonize 1.000 ml blood. Ozone was obtained from oxygen by a precision generator. All treatments stopped when animals were no longer lame. Cost of the milk is US\$ 0.4/l. The price of high milk obtained by the breeder at farm level is due to the high farm costs sustained in order to feed cows. The ration is largely composed of Alfa-Alfa hay produced on the farm and concentrates bought on the market. The consortium of conservation of the Parmigiano-Reggiano cheese imposes the respect of feeding rules to obtain high quality milk destined to transformation in cheese. The local cost of labor per hour is US\$ 7. An ozone generator costs US\$ 3000: we have considered 4 years of economic duration for this instrument. The technical duration of this instrument can be prolonged, but this prolongation may create two disadvantages: an increase in the maintenance costs and a reduced efficiency of the instrument. Normally, after a period of 4 years, the technological obsolescence of an instrument and the new technical offers by the market impose the substitution of the instrumental capital. Prices and costs are reported in U.S. dollars and refer to the end of 1999. Data was analyzed with the coupled *t-test of Student*. Statistical significance was set at  $P < 0.05$ .

Table 3. Total cost of therapy in different treatment groups (US\$ per cow).

		Ceftiofur	Oxytetracycline	Ozonized Autohemotherapy
Consumption material (syringes)	a	3	7	1
Cost of syringes	b	0.3	0.7	0.1
Consumption material (flask)	c	0	0	1
Cost of flask	d	0	0	4
Consumption anticoagulant (vial)	e	0	0	1
Cost of anticoagulant	f	0	0	1
Total consumption costs	g	0.3	0.7	5.1
		(b+d+f)	(b+d+f)	(b+d+f)
Cost of drugs	h	30	12	0
Veterinary service *	i	50	75	50
Total therapy costs	j	80.3	87.7	55.1
		(g+h+i)	(g+h+i)	(g+h+i)

\* Cost evaluation of veterinary service by type of intervention: the cost of oxytetracycline therapy results larger because of the greater cost of this drug compared with the others.

## Results and discussion

All the lameness stopped after  $1.5 \pm 0.8$  d of ceftiofur treatments ( $1.5 \pm 0.4$  d),  $3 \pm 0.9$  d of oxytetracycline treatments ( $3 \pm 0.9$  d) and  $1 \pm 0.0$  d of ozone autohemotherapy treatment ( $1 \pm 0.0$  d) (Table 1). Treatment numbers and days were significantly lower (see Table 1) in the cows treated with ozone ( $P < 0.001$ ). Foot rot healing looks better in ozone

treated cows than in antibiotics treated cows.

Milk was discarded during and after ceftiofur and oxytetracycline therapy respectively for two and ten days, but not during and after ozone therapy. The economic loss (direct and indirect costs - Tables 2, 3, 4, 5) for ceftiofur sodium treatment was US\$ 105.20: the cost of oxytetracycline chloridrate treatment was US\$ 208.60, while that of ozone treatment was only US\$ 58.60 per cow (Table 6).

Table 4. Labor cost in different treatments: separation of the treated heads and the respective milk (US\$ per cow).

		Ceftiofur	Oxytetracycline	Ozonized autohemotherapy
Farm labor separation cows (min/head)	a	2	2	0
Farm labor separation milk (min/head)	b	1	1	0
Farm labor treatment therapy (min/head)	c	5	5	30
Total farm labor (min/head)	d	8 (a+b+c)	8 (a+b+c)	30 (a+b+c) *
Total labor cost (US\$ 7/h)	e	0.93	0.93	3.50

\* The ozonized treatment therapy during this experiment took about 30 minutes per cow.

Table 5. Milk loss value during different treatments (US\$ per cow).

		Ceftiofur	Oxytetracycline	Ozonized autohemotherapy
Treatment time (d)	a	1.5	7	1
Drug withdrawal period (d)	b	0.5	3	0
Total discarded milk period (d)	c	2 (a+b)	10 (a+b)	0 (milk was not discarded)
Milk yield per cow (l/d)	d	30	30	30
Total discarded milk treatment period (l)	e	60 (cxd)	300 (cxd)	0 (cxd)
Milk price at farm level (US\$/l)	f	0.4	0.4	0.4
Total milk loss value (US\$)	g	24 (exf)	120 (exf)	0 (exf)

### *Clinical Implications*

The use of ozone autohemotherapy for dairy cow foot rot was as effective as ceftiofur and oxytetracycline treatments. Only one ozone treatment for one day was necessary to resolve lameness, while with ceftiofur and oxytetracycline we had to treat cows for an average of 3 times (1.5 and 3 days respectively). Ozone treatment was therefore the shortest when compared to antibiotic treatments. Moreover, the healing of foot rot in ozonized cows look better than in cows treated with antibiotics. In fact, according with some authors (Whitney, 1989; Quirinia and Viidik, 1995), the availability of oxygen caused by ozone autohemotherapy to tissues, plays an important role in the process of wound healing.

### *Economic Implications*

From an economic point of view, ozone therapy cost was the cheapest: total treatment costs are

lower using ozone autohemotherapy. Great difference between treatment costs relate to indirect costs, because using antibiotics in dairy cow make it necessary to discard milk during and after the treatment period for some days, while during and after ozone treatment milk can be normally used.

In the months subsequent to treatment, animals treated with ozone autohemotherapy showed a smaller incidence of acute interdigital phlegmon compared to animals treated with antibiotics; however, these results were not statistically significant.

### **Conclusions**

It may be concluded that ozone treatment in autohemotherapy had the same clinical results in foot rot treatment when compared to ceftiofur and oxytetracycline treatment, but was significantly the fastest and the cheapest.

Table 6. Total cost (US\$) per cow using ceftiofur sodium, oxytetracycline chloridrate and ozone autohemotherapy treatment in foot rot.

	Ceftiofur	Oxytetracycline	Ozonized autohemotherapy
Total therapy cost	80.3	87.7	55.1
Total milk loss value	24	120	0
Depreciation and maintenance total tool cost	0	0	1.0
Total labor cost (US\$ 7/h)	0.93	0.93	3.50
Total cost	105.2	208.6	59.6

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