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Efficacy of homeopathic and antibiotic treatment strategies in cases of mild and moderate bovine clinical mastitis

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The objective of this clinical control trial was to examine the effectiveness of the classical homeopathic treatment strategy in cases of mild and moderate bovine clinical mastitis in comparison with antibiotic and placebo treatments. Owing to characteristics of the selected herds, only cases of clinical mastitis caused by environmental pathogens and clinical cases with negative bacteriological result in the pre-treatment milk sample were included in the trial. A total of 136 lactating dairy cows with 147 affected quarters from four herds in Germany were randomly allocated to three treatment groups. The cows were examined on days 0, 1, 2 and on days 7, 14, 28 and 56 post initial infection to assess clinical signs. Simultaneously, with the exception of days 1 and 2, quarter milk samples for laboratory examinations (bacteriology, somatic cell count) were collected to assess bacteriological and cytological cure rates. On days 28 and 56, treatment strategies did not differ significantly with respect to the clinical outcomes and the total cure rate in cases of bacteriological negative mastitis (n=56). In cases of pathogen-positive mastitis (n=91), the cure rate after 4 and 8 weeks was similar between the two treatment strategies, homeopathy and antibiotic treatment, but the difference between the homeopathic and the placebo treatment at day 56 was significant (P<0·05). The results indicate a therapeutic effect of homeopathic treatment in cases of mild and moderate clinical mastitis. However, independent of treatment strategy and bacteriological status, the total cure rate was on a low level, revealing limitations in the effectiveness of both antibiotic and homeopathic treatment strategies.

Keywords: Clinical mastitis, homeopathy, antibiotic therapy, treatment strategy, total cure rate.

Bovine mastitis is one of the main animal health problems in conventional and organic dairy herds (Hovi et al. 2003; Ruegg, 2008). Prevalence rate of clinical mastitis in dairy herds varies considerably within and among dairy farms (Pol & Ruegg, 2007; Olde Riekerink et al. 2008). In modern herd health management, the implementation of preventive mastitis programmes against contagious pathogens resulted in an increase of clinical mastitis cases caused by environmental pathogens like *Streptococcus uberis, Escherichia coli* and minor pathogens (Hillerton & Berry, 2005). Apart from preventive measures, the effectiveness of the therapy used is critical for udder health status at the farm level.

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The most common treatment strategy in the case of clinical mastitis is the use of antimicrobial drugs (Pyörälä, 2002; Vaarst et al. 2006). However, their use in dairy farming is not without controversy, especially for organic dairymen. In the United States (US), the national organic standards prohibit the use of antimicrobial drugs if the treated animals are to be sold as organic (USDA, 2002). In the European Union (EU), the EU-Regulation (889/2008) on organic livestock production contains a restriction on only three treatments with chemically synthesized remedies per lactation. To reduce the use of antibiotics in organic livestock production, the Regulation postulates that '…homeopathic and phytotherapeutic remedies shall be used in preference, provided that their therapeutic effect is effective for the species of animal and the condition for which the treatment is intended'. Many organic dairymen try to adopt this demand in their workaday life, especially

in the case of mastitis therapy. Studies from research groups in the United Kingdom (UK) and Germany show that 34–51% of clinical mastitis cases were treated with homeopathic remedies (Hovi & Roderick, 2000; Krömker & Pfannenschmidt, 2005), although only a few papers have been published so far on using homeopathy as a treatment strategy in mastitis therapy. Clinical studies dealing with the use of homeopathy have often been criticized for their inadequate scientific approach, e.g. for not conducting randomized clinical trials (RCT) (Cucherat et al. 2000). Some authors also assume that any beneficial effects of homeopathy are primarily due to a placebo effect or a non-specific stimulus (Shang et al. 2005) implicating the need of an adequate control group. While Hektoen et al. (2004) implemented two control groups (placebo and antibiotic treatment) in their study, other studies included only one control treatment, by providing either a placebo (Meaney, 1995), antibiotic treatment (Garbe, 2003; Varshney & Naresh, 2005) or a non-treatment (Turner, 2001). Moreover, most of the previous studies focused on the effectiveness of a mixture of remedies conflicting with the law of similia in classical homeopathy demanding that only one remedy can be the most similar at any given time to the condition of any given patient. There is a need for papers demonstrating the possibility to design scientifically sound studies to prove the effectiveness of homeopathic mastitis therapy under practical conditions by using the RCT design. The objective of the present clinical trial was to assess the effectiveness of the classical homeopathy treatment strategy in comparison with antibiotic and control treatment using a placebo in the case of mild or moderate acute clinical mastitis.

Materials and Methods

The study took place from May 2003 until October 2005 and was conducted in one organic and three conventional dairy herds in Germany. Herd size varied from 75 to 300 cows in milk. Cows were managed in either a cubicle yard or a deep-litter house and divided into different lactation groups. The herds followed a twice-daily milking regimen. In each herd, cow milk samples were collected monthly for measuring milk yield and somatic cell count (SCC). Foremilking was practised by all of the four herds, as well as post-milking teat disinfection. Owing to a lack of valid data concerning the status quo of present pathogens in the herds, quarter foremilk samples were collected from all lactating cows at the beginning of the study. Isolates from these samples were used to identify major and minor pathogens, and for in-vitro antimicrobial susceptibility tests. Cows suffering from mastitis were identified at milking time by the farmer, subsequently confirmed by the project veterinarian examining the cows for inclusion. Cows eligible for enrolment were lactating dairy cows with mild or moderate clinical mastitis, characterized by signs of inflammation in the affected udder quarter (swelling, redness, induration, heat or pain) and/or by the presence of evident changes in milk composition (chunks, flakes, clots or blood). Each mastitic udder quarter was enrolled only once per lactation. Cows were excluded if they had a rectal temperature >39·5 °C or were showing systemic signs of depression or watery milk. In addition, cows with visible signs of teat lesions were excluded from the study.

Study design

The study was performed as a RCT according to the defined criteria of the European Agency for the Evaluation of Medicinal Products (EMEA, 2003). On each farm, the cows that fulfilled the inclusion criteria were randomly allocated to the homeopathic treatment strategy (test group), to the antibiotic treatment strategy or to the placebo group (control groups). Randomization of clinical mastitis cases was ensured by throwing the dice after the anamnesis and the initial examination were performed. In all cases randomization was done on cow-level. In the study, a modified semi cross-over design was used. Patients defined as non-responders had to cross over to one of the two other treatment groups following pre-defined criteria described in a subsequent section.

The farmers were blinded in the case of homeopathic and placebo treatments. Both the homeopathic and placebo remedies for per oral use were filled in test tubes looking identical with regard to quantity and colour of remedy, physical appearance and labelling. This blindness was ensured until day 5 after the beginning of the treatment where the application of the placebo was finished. In consideration of ethical aspects and in the face of an iatrogenic infection after installing a placebo in the teat canal, we did the treatment without a local placebo treatment in homeopathic and placebo groups. Correspondingly, the farmers were aware of an antibiotic treatment from the time when they had to perform the follow-up treatment. By contrast, the laboratory personnel were blinded to treatment allocation over the whole time.

Clinical examination

Cows meeting the inclusion criteria of the study were clinically examined by the project veterinarian before the first treatment on day 0 and again on days 1, 2, 7, 14, 28 and 56 post infectionem. On each examination, in addition to the general appraisal of the cow, both the affected udder quarter and its secretion were assessed using a modified score system that graded the severity of signs of inflammation and changes in milk composition, respectively (Rosenberger, 1990). Scoring was performed by inspection of milk composition before and palpation of the affected udder quarter after milking. The palpation score ranged from 0 to 10, the milk score from 0 to 6. Score 0 was used to describe a normal quarter free from inflammatory signs and with secretion of normal milk character.

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Treatment strategies

Cows randomly allocated to group H were treated with classical homeopathic treatment strategy according to Hahnemann's theory based on treating and curing like with like (Hahnemann, 1999). For each patient, the appropriate 'similium' had to be found. A similium is a single substance that, given to a healthy individual, would produce the same symptoms as expressed by the patient. To find the appropriate similium in a transparent way, an anamnesis sheet was developed. The sheet supported the documentation of all signs of illness including behavioural symptoms and the specialities of homeopathic anamnesis like weather, modality and constitutional type. This sheet was completed by the trained project veterinarian for every cow that met the inclusion criteria. The procedure resulted in the identification of the most appropriate medication in the given case at the given time. To adjust the selection of the remedy based on the examiner's decision, the completed sheets were promptly sent to an independent homeopathic expert who trained the project veterinarian before the study began.

The homeopathic and placebo remedies were composed of sugar-based globuli and were produced by Deutsche Homöopathie-Union (DHU, Karlsruhe, Germany) in compliance with the methods described in the German Homeopathic Pharmacopoeia (HAB). For oral administration, the remedies were dissolved in water and drawn up in a syringe. The placebo globuli administered to cows allocated to group P, were given twice a day for 5 d. The application interval of the homeopathic remedies was determined depending on the potency of the similium. In the vast majority of cases, low potencies (D6, D12) were used, also given twice a day for a minimum of at least 5 d. The remedies most commonly used in the study according to their characteristic symptoms concerning mastitis were *Phytolacca decandra, Bryonia alba, Pulsatilla pratensis, Mercurius solubilis, Hepar sulfuris* and *Apis mellifica*. In the course of the healing process, relevant symptoms can change and then correlate with symptoms of another remedy. Therefore, a change of the homeopathic remedy was allowed if the cow was not defined as a non-responder to treatment strategy.

Cows randomly allocated to group A were treated in accordance with the guidelines for prudent use of antimicrobials in veterinary medicine (Ungemach et al. 2006). Thus, the antibiotic initially administered to the cows suffering from mastitis was an antibiotic with a narrow spectrum of activity, proven to be effective against the provable pathogens which were isolated in milk samples of the herd samplings at the beginning of the study. The chosen antibiotic (Cloxacillin 1000®, containing 1000 mg of cloxacillin as cloxacillin-natrium; Medistar, Germany) was aseptically administered via the teat canal in the affected udder quarters on three consecutive days after milking with 24-h interval. On the basis of microbiological results from milk of the diseased udder quarter, treatment was changed if an isolated pathogen was identified to be resistant to cloxacillin. In these cases, an antibiotic with a broad spectrum of activity (CobactanLC®, containing 75 mg cefquinom; Intervet, Germany) was injected into the teat after milking on three consecutive milkings, according to the manufacturer's instructions. Initially, the project veterinarian administered the remedies according to the appropriate treatment strategy while the following applications were given by the dairymen.

Affected cows showing an increase in local signs at the times of clinical examination had to cross over to another treatment strategy. They were classified as non-responders to the first treatment, according to Hektoen et al. (2004). The decision for changing the treatment strategy was taken by the project veterinarian. Non-responders in the homeopathic treatment were subsequently treated with antibiotic drugs while non-responders, previously treated with antibiotics, changed to the homeopathic treatment strategy. A change from homeopathic to antibiotic treatment strategy was also indicated after numerous changes of homeopathic remedy as a result of modifications of the symptoms. Furthermore, mastitis cases initially treated with allopathic remedies had to cross over to homeopathic treatment in cases of provable negative bacteriological result in the milk sample on day 0. Randomization to homeopathic or antibiotic treatment strategy was repeated in case of non-responders in the placebo group showing no signs of healing process in the first 5 d. Cows with systemic signs, evaluated by body temperature, were excluded from the trial and immediately treated with antibiotics and anti-inflammatory drugs for ethical reasons.

Milk sampling and laboratory analysis

Milk samples were collected aseptically from all affected and unaffected udder quarters of the included cows on days 0, 7, 14, 28 and 56 post infection. Before the sampling, all teat ends were scrubbed with a tissue moistened in 98% alcohol. After discarding the first 2–3 strippings, a milk sample (8–10 ml) was collected into a sterile test tube containing 1·5 ml boric acid for conservation. They were immediately sent to the laboratory for bacteriological and SCC analysis and for antimicrobial susceptibility test. Identification of microorganisms was conducted using standard methods according to the recommendations of the International Dairy Federation (IDF, 1981). Approximately 0·1 ml of milk was cultured on blood (5% bovine blood and 0·1% aesculin) agar plates (Oxoid, Wesel, Germany) and incubated at 37 °C for 40–48 h. In this time, two evaluations of the plates at intervals of 20–24 h were performed. Laboratory tests for the identification of bacteria included colony morphology, haemolysis, coagulase reaction, catalase test (Blobel & Schliesser, 1994), CAMP-reaction, Lancefield grouping (Phadebact® Streptococcus Test C), biochemical reactions (API 20 STREP®; bioMérieux, Germany), Gram-staining, oxidase reaction, colony growth on GASSNER-Agar (Oxoid, Wesel, Germany)

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and indole-test. Yeasts were confirmed by growth on SABOURAUD-Agar and were differentiated from *Prototheca* spp. by microscopy of a fresh preparation. Bacterial isolation was targeted on the identification of *Staphylococcus aureus, Streptococcus agalactiae, Streptococcus dysgalactiae*, aesculin-positive streptococci, other streptococcal species, *Escherichia coli*, other coliform pathogens, CNS species, *Arcanobacterium pyogenes*, *Prototheca* spp. and *Candida* spp. Isolation of any of the mentioned pathogens was considered an intramammary infection. Samples were classified as contaminated if three or more bacterial types were isolated from one milk sample. Samples not containing any of the above pathogens were recorded as exhibiting no significant growth.

Quarter milk SCC was determined by a fluorescence method using a Fossomatic system (360N, Foss Electronic, Hamburg, Germany). The in-vitro antimicrobial susceptibility test was conducted with a modified agar disk diffusion method (Bauer et al. 1966). For categorizing the results, criteria of the Clinical and Laboratory Standards Institute (CLSI, 2009) were employed to evaluate isolates as susceptible, intermediately susceptible or resistant.

Classification of outcomes

Treatment outcomes were assessed on several grades. Clinical cure was defined as the return of quarter and secretion to normal (scores 0 and 1), separate on each day of clinical examination. It was assessed by visual observation of milk composition and palpation of the udder. Bacteriological cure of a pathogen identified on day 0 was defined as the failure to isolate the same pathogen in either of the milk samples collected on days 7–56. Analysis of bacterial cure rates did not include quarters whose milk samples did not contain any of the pathogens mentioned above. A total cure of an udder quarter was defined as having clinically and bacteriologically cured and showing a SCC of $<100\,000$ cells/ml milk in the quarter milk sample at each observation time. This definition is in accordance with the definition of a healthy udder quarter published by the German Veterinary Medical Society (DVG, 2002).

Statistical analysis

Statistical analyses were carried out using SAS/STAT® software (SAS Inc, Cary NC, USA). The experimental unit for randomization was the cow. In all analyses, the treatment effects were estimated based on the udder quarter (EMEA, 2003). Following the intention-to-treat principle, the analyses included all randomized cows, no matter whether they were treated with the allocated therapy up to the end of the observation period or not. If a change of treatment was necessary (non-responders), all subsequent data were replaced with the last available values at time of crossover. These values were carried forward and used in the subsequent comparisons of outcomes of the different treatment strategies according to the last-observation-carried-forward (locf) analyses of missing values (EMEA, 2001). The locf-analysis allows the evaluation not only of a treatment success but also of worsening of mastitic cows in spite of treatment.

Group differences at baseline were tested by chi-square tests or Kruskal Wallis tests when appropriate. Treatment effects were estimated by generalized linear models, where the respective outcome parameter was modelled as a function of the group, the time of the measurement, the group-time interaction and, if available, the parameter's baseline value. If the outcome parameter was continuously scaled, it was assumed to be log-normally (SCC) or normally distributed (all others). Ordinal and nominal scaled parameters were taken as multinomially or binomially distributed and linked to their predictors by cumulative or simple logit-functions. All analyses were separately performed for quarters whose milk samples did and did not contain any of the identified pathogens. For all comparisons, $P<0{\cdot}05$ was considered to be significant.

Results

Taking the inclusion and exclusion criteria into account, the study included 136 lactating dairy cows with a total number of 147 affected quarters. Mild or moderate clinical mastitis cases were randomized to homeopathic treatment ($n=58$), antibiotic treatment ($n=46$) or to the placebo group ($n=43$). The means of the most important initial conditions did not differ ($P>0{\cdot}05$) among the treatment groups (Table 1).

Herd quarter milk samples taken from the four farms prior to beginning the study were negative for contagious pathogens. Of the 147 pre-treatment milk samples from clinical mastitis cases, 91 were positive for bacterial growth. Forty-two percent of the isolated pathogens ($n=38$) were identified as aesculin-positive streptococci, 21% ($n=19$) as coagulase-negative staphylococci (CNS) and 18% ($n=16$) as *Esch. coli* ($n=13$). Others (10%) included *Str. dysgalactiae* ($n=5$), coliforms ($n=3$), *Proteus* spp., *Arcanobacterium pyogenes*, *Prototheca* spp., *Candida* spp. and other aesculin-negative streptococci. In 7 milk samples, two pathogens were isolated (mixed infections), and one milk sample was contaminated ($\geqslant 3$ pathogens). From 56 milk samples (38%) collected before treatment on day 0 no pathogen was isolated.

Of the 147 mastitis cases, 39 (26·5%) had to cross over to another treatment strategy. Cows given a placebo had to change significantly earlier (5 d after the beginning of treatment) and in more cases (46·5%) than cows treated with homeopathic or allopathic remedies (20·7% on day 13 and 15·2% on day 12, respectively), although nearly half of them had a negative bacterial status at pre-treatment sampling.

Results of the initial palpation of diseased udder quarters did not differ significantly between the treatment groups (Table 2). Independent of treatment strategy,

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Table 1. Initial conditions of udder quarters suffering from mild or moderate clinical mastitis by treatment strategy

Initial conditions		Treatment strategy: Classical homeopathy (n=58)	Antibiotic (n=46)	Placebo (n=43)	All patients (n=147)
Affected quarter†	RF	12	13	13	38
	RR	15	9	11	35
	LF	14	13	12	39
	LR	17	11	7	35
Lactation number		2·7 ± 1·8	2·5 ± 1·1	2·9 ± 1·3	2·7 ± 1·5
Days in milk		79·5 ± 75·6	104·1 ± 86·3	114·9 ± 85·3	97·5 ± 82·8
Milk yield,‡ kg/d		32·5 ± 10·7	34·1 ± 11·7	31·8 ± 9·1	32·8 ± 10·6
SCC§		430·4 ± 1395·8	267·1 ± 568·4	636·5 ± 1642·1	438·2 ± 1284·3
Bacterial isolates¶	no	19	17	20	56
	yes	39	29	23	91

† Position of infected quarter: RF = right front, RR = right rear, LF = left front, LR = left rear
‡ The last value in herd program before clinical mastitis (measured monthly)
§ The values are given in thousands (10^3). The highest number was 9999 being the last one registered in somatic cell counter at monthly measuring
¶ The presence of bacteria in milk samples of infected quarters at day 0 before treatment

Table 2. Average of the scores evaluating results of clinical examination of udder quarters suffering from mild or moderate clinical mastitis by treatment strategy

Day of Examination	Bacterial isolates negative (n=91)						Bacterial isolates positive (n=56)					
	Milk score			Palpation score			Milk score			Palpation score		
	H†	A†	P†	H	A	P	H	A	P	H	A	P
0	3·6	3·9	3·5	5·6	5·4	4	3·9	4·1	3·9	5·9	5·3	5·6
7	1·3	1·1	1·4	1·9	3·2	2·2	$1·4^{a}$	$0·5^{b}$	$2·5^{c}$	$3·0^{a}$	$3·2^{b}$	4·2
14	$0·5^{a}$	0·8	$1·4^{b}$	1·6	2·5	2	$1·2^{a}$	$0·2^{b}$	$2·3^{c}$	$2·1^{a}$	2·4	$4·0^{b}$
28	0·8	1·1	1·4	1·1	2·6	1·7	$1·1^{a}$	$0·4^{a}$	$2·6^{b}$	$2·2^{a}$	$1·4^{a}$	$3·9^{b}$
56	0·7	1·0	1·2	1·2	2·3	1·6	$1·1^{a}$	$0·3^{b}$	$2·3^{c}$	2·1	$1·1^{a}$	$3·8^{b}$

† H = Classical homeopathy, A = Antibiotic treatment, P = Administration of a placebo
^{a,b,c} Values within a row with different superscript letters are different (P<0·05)

clinical mastitis cases with negative bacteriological status on day 0 showed a reduction of hardening especially in the first week after the start of treatment. Mastitis cases with positive bacteriological status at day 0 showed the largest reduction of hardening after antibiotic treatment. The application of a placebo did not lead to a substantial decrease of rigidification in the observed period.

With respect to the milk score, the outcomes of visual changes in the milk were similar for bacteriological negative affected quarters in the three groups over the time of examination except for day 14. In cases of mastitis with positive bacteriological status, the quarters treated with antibiotics showed the largest reduction of flocculation, followed by the homeopathic group.

Randomized treatment strategy marginally influenced the bacteriological result in the milk samples collected at different times during the observation period, although the percentage of bacteriological cure rate after antibiotic treatment was the highest at each time, especially on day 7 (Table 3). The bacteriological cure of udder quarters treated with homeopathic and placebo remedies was similar.

Treatment of bacteriological negative mastitis cases did not influence the SCC (P>0·26). In contrast, SCC of mastitis cases with positive bacteriological status on day 0 in the placebo group persisted at >10^6 cells/ml at all days of examination in contrast to both treatment strategies (P<0·01). The rate of total cure showed no differences (P>0·08), neither between the homeopathic and antibiotic treatment strategies nor between the two treatment strategies and the placebo group until the day 28, independent of the bacterial status at pre-treatment sampling (Table 4). Only in the case of bacteriological positive mastitis, a difference in total cure between the placebo group and homeopathic treatment strategy was obvious on day 56 (P=0·03).

Discussion

A comparison of cure rates found in our study with those in other studies is difficult because of differences in study design, clinical procedures and evaluation of outcomes.

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Table 3. Bacteriological cure by treatment strategy and time of examination

	Treatment strategy						*P*		
	H†		A†		P†				
Day of examination	(no./no.)‡	(%)	(no./no.)‡	(%)	(no./no.)‡	(%)	H/A	H/P	A/P
7	17/39	43·6[b]	24/29	82·8[a]	13/23	56·5[b]	0·00	0·37	0·04
14	24/39	61·5	24/29	82·8	15/23	65·2	0·08	0·87	0·15
28	23/39	59·0	24/29	82·8	13/23	56·5	0·07	0·98	0·10
56	24/39	61·5	24/29	82·8	13/23	56·5	0·11	0·79	0·25

† H = Classical homeopathy, A = Antibiotic treatment, P = Administration of a placebo
‡ Number of cases bacteriologically cured out of number of cases treated. Number of cases treated was the same over the time according to the intention-to-treat-principle
[a,b] Values within a row with different superscript letters are different ($P<0·05$)

Table 4. Total cure rate (%) of clinical mastitis cases by treatment strategy and time of examination

Day of examination and bacteriological status at day 0		Treatment strategy			*P*		
		H†	A†	P†	H/A	H/P	A/P
Negative ($n=56$)	7	21% (4/19)	6% (1/17)	25% (5/20)	0·13	0·92	0·14
	14	30% (5/19)	35% (6/17)	35% (7/20)	0·82	0·82	1·00
	28	47% (9/19)	29% (5/17)	30% (6/20)	0·27	0·27	0·96
	56	47% (9/19)	24% (4/17)	30% (6/20)	0·14	0·27	0·65
Positive ($n=91$)	7	10% (4/39)	3% (1/29)	0% (0/23)	0·20	0·29	0·87
	14	18% (7/39)	21% (6/29)	0% (0/23)	0·73	0·11	0·08
	28	18% (7/39)	21% (6/29)	4% (1/23)	0·77	0·15	0·12
	56	31% (12/39)[a]	24% (7/29)	4% (1/23)[b]	0·55	0·03	0·08
All treated mastitis cases ($n=147$)	7	14% (8/58)[a]	0% (0/46)[b]	9% (4/43)	0·05	0·57	0·11
	14	21% (12/58)	24% (11/46)	14% (6/43)	0·67	0·44	0·26
	28	28% (16/58)	24% (11/46)	16% (7/43)	0·67	0·18	0·37
	56	36% (21/58)[a]	24% (11/46)	16% (7/43)[b]	0·18	0·03	0·37

† H = Classical homeopathy, A = Antibiotic treatment, P = Administration of a placebo
[a,b] Values within a row with different superscript letters are different ($P<0·05$)

The study design used in the present trial fulfilled the criteria of a RCT demanding comparative treatment groups, randomization, blinding (as far as is practically possible) and defined inclusion and exclusion criteria (EMEA, 2003). The trial was performed single blind. This characterization of blindness can be considered as questionable because there are the same application methods for homeopathic remedies and placebo, but the duration of therapy was not exactly the same in these treatment groups. However, in the first days of treatment being essential for the healing process (Hillerton & Berry, 2003), blindness was ensured. Furthermore, the farmers did not achieve extraordinary expenditures for mastitic cows counteracting any expectations in regard to treatment success.

In cases of mild and moderate mastitis, antibiotics injected into the teat are considered a well-established standard procedure in veterinary medicine (Pyörälä, 2002). Nevertheless, we found only deficient data related to mastitis therapy which compared the effect of an antibiotic treatment with a non-treated or placebo-based group (Hillerton & Kliem, 2002; Roberson et al. 2004). Most of the reviewed studies compared the effectiveness of different antibiotic treatment strategies (McDougall, 2003; Sérieys et al. 2005). Before the homeopathic treatment strategy can be accepted as an alternative in mastitis therapy, it has to produce similar cure rates compared with the antibiotic treatment strategy.

In the trial, only cases of mild or moderate clinical mastitis were included. All mastitis cases were caused either by environmental pathogens or showed no provable pathogen in the pre-treatment milk sample. We found a high rate of bacteriological negative mastitis cases in our study, which is similar to the study of Krömker et al. (2010). In these cases, the use of antibiotics is unnecessary and must be assessed as contra-indicated. The findings emphasize the demand for a fundamental diagnostic based on the herd and on the single cow for gaining essential information to realize a high effectiveness of treatment, independent of the strategy cows were treated with. Furthermore, in our opinion, contagious pathogens had to

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be excluded from mastitis studies dealing with alternative medicine because of their epidemiological background and the existence of well proven conventional elimination strategies (Hillerton et al. 1995). In addition, the study of Garbe (2003) showed only a lower efficacy of homeopathy against udder-associated pathogens.

Direct comparisons of the results of clinical examination with other studies are barely meaningful because of the lack of a standard definition for 'clinical cure'. A defined score evaluating clinical signs of the diseased udder has not been established so far. The analysis of separate clinical outcomes in the present survey showed a fast reduction in flocculation, but a slow regeneration of the udder parenchyma, independent of an involvement of pathogens.

In contrast to the heterogeneity of clinical evaluation, the 'bacteriological cure' of treated mastitis cases is clearly defined in the literature on mastitis. In the present study, the elimination rate of mastitis-causing pathogens after homeopathic treatment was on a higher level compared with those of other studies (Garbe, 2003; Hektoen et al. 2004). Indeed, also the bacteriological cure after the administration of a placebo is clearly higher in comparison with the results of Hektoen et al. (2004). The bacteriological cure rates in the antibiotic treatment group correspond with results in previous conventional mastitis studies (Hillerton & Kliem, 2002). Nevertheless, the self elimination rate is considerably higher than those of the antibiotic treatment strategies in previous studies with the objective of testing homeopathic mastitis therapy (Garbe, 2003; Hektoen et al. 2004). These differences could be explained to some degree by the exclusion of mastitis caused by *Staph. aureus* in the present study which was not an exclusion criterion in the mentioned studies.

Only a few of the previous mastitis studies have analysed the total cure rate, although the combination of all evaluated parameters (palpation, flocculation, SCC and bacteriological status) permits the concept of whole healing without remaining damage. The functional state of the tissue which existed before the illness is completely restored. In the present study, the total cure rate of non-specific clinical mastitis cases did not statistically differ between the treatment strategies. It was similar to the cure rates of Krömker et al. (2010). In cases of mastitis with positive bacteriological status on day 0, our results after homeopathic treatment are comparable to those of earlier studies (Garbe, 2003; Hektoen et al. 2004), while the total cure rate of mastitis cases treated with antibiotics was on a lower level than in similar publications (Garbe, 2003; Krömker et al. 2010). Hektoen et al. (2004) found no statistical difference in cure rates between the homeopathic and placebo treatment at day 28, comparable to our results. The significant difference between these groups at day 56 in the present study approved an effectiveness of the homeopathic treatment strategy as a 'regulation therapy' stimulating the activity of immune response and resulting in a long-time healing.

Conclusions

The results indicate a therapeutic effect of homeopathic treatment in cases of mild and moderate clinical mastitis that were caused by environmental pathogens or showing no provable pathogen in the milk sample on day 0. The cure rates of both homeopathic and antibiotic treatment were comparably low revealing limitations in the effectiveness of both treatment strategies. Nevertheless, the homeopathic treatment strategy might be an alternative to the use of antibiotics in cases of mild and moderate clinical mastitis. However, exclusion of mastitis caused by udder-associated pathogens in the dairy herd in combination with an improved farm- and cow-specific diagnostic procedure is an important precondition when using the homeopathic treatment strategy.

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