

Cold atmospheric plasmas in medicine – where we are today, and where we are heading

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Cold atmospheric plasmas (CAPs) are of considerable interest in medicine due to their versatility in design and their broad application spectrum, especially for in vivo applications in germ related superficial skin diseases. But did they meet the early enthusiastic expectations, or not? 7 years after starting first clinical trials in patients it is time to make a first résumé. Simply spoken: Yes, they did.

Microwave driven cold atmospheric argon plasma demonstrated to be a very safe and effective add-on therapy in patients with chronic infected wounds. A 5 min therapy regimen led to a highly significant higher germ reduction in plasma treated wounds compared to controls (34%, $p < 10^{-6}$, 36 patients, 291 applications, MicroPlaSter alpha). [1] Subsequent studies revealed that a 2 min treatment in 2 generations of devices led to significant (40%, $p < 0.016$, 14 patients, 70 applications, MicroPlaSter alpha) or highly significant reduction (23.5%, $p < 0.008$, 10 patients, 137 applications, MicroPlaSter beta) respectively. [2] The antibacterial effects were independent of the bacterial species and the resistance level. No side-effects occurred and the treatment was well tolerated.

A rapid clinical improvement has also been reported in a patient with Hailey-Hailey disease resistant to topical disinfectants and corticoids with a secondary infection with *Candida albicans* and *Proteus mirabilis* using the MicroPlaStar beta device. [3]

If plasma has beneficial effects in itching diseases is still unclear. A study conducted in 46 patients with different itching diseases did not lead to a significant reduction of itch compared to a control application of argon gas (placebo mode). [4] But both legs led to a significant relief of itch. Further studies with a different approach are necessary to answer this question.

Next generation of cold atmospheric air plasmas already demonstrated their efficacy and safety in a phase I study and are in the starting blocks for further clinical investigations.

To summarize, the future of CAPs in medicine and hygiene is very promising, broadly based and exciting.

References

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