Early experience with a novel aerosol formula of silver sulfadiazine, lidocaine, and vitamin A in the treatment of scalp pressure ulcers

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Background: Management of scalp pressure ulcers (SPU) in patients admitted to an intensive care unit (ICU) remains a challenge. The impossibility of freely moving the head due to different factors, such as the intubation, enteral nutrition, dialysis and use of extracorporeal membrane oxygenation, makes the management of these wounds problematic. The authors present their early clinical experience in the treatment of SPU with a novel aerosol formulation of silver sulfadiazine. **Methods:** A prospective case series including all patients with SPU who were treated with an aerosol formula that includes silver sulfadiazine, lidocaine and vitamin A (Platsul A®, Soubeiran Chobet, Argentina) was carried out. Wound dressings were changed every 12 hours. The wound was cleansed and aerosol and occlusion with sterile gauze applied. The evolution of each SPU was gauged with pictures and measurements of the affected area every 48 hours. In order to determine the total wound area, pictures were analysed using the Informatics Image System from the US National Institute of Health. **Results:** Six patients were prospectively followed and included in this study. There were two females and four males. The average age was 70.8 years (range 41–99 years), while the average hospital stay in the ICU was 14 days (range 5–22 days). None of these patients experienced wound progression to a more critical stage. One patient had a favourable resolution from stage IV to stage II. Also, none of the SPU showed clinical signs of a local infection. The average quantity of aerosol used per dressing was 1.3 ml, which represents 2.6 mm/day and a cost of U$S1.45. The cost of hydrocolloid dressings at the authors' institution is U$S8.24 per dressing, representing an important cost saving. **Conclusions:** In this case series, the use of this novel aerosol formulation of silver sulfadiazine has shown promising results in the treatment of SPU in patients admitted to an ICU, facilitating healing and saving money. Further and larger studies to confirm these encouraging preliminary results are warranted.

Author details can be found on p29

The scalp is the most external physical barrier and helps protect the skull. The management of scalp pressure ulcers (SPU) in patients admitted to an intensive care unit (ICU) remains challenging (Prado and Andrades, 2005; Nijs et al, 2008; Yepes et al, 2009). Poor clinical condition, impaired tissue perfusion and inability to move the head because of intubation, enteral nutrition, dialysis and use of extracorporeal membrane oxygenation, among

Figure 1. Evolution of each scalp pressure ulcer (SPU) was controlled with pictures and a ruler on the affected area every 48 hours.

others, makes the management of these wounds problematic. Therefore, there is a need to develop strategies to reduce the morbidity and economic impact associated with PUs of the scalp.

Complex microbiological ecosystems, including biofilms, have been detected in PUs (Bowler and Davies, 1999; Ge et al, 2002). Several authors have highlighted the risk of biofilm formation in tissue infections, which has been recognised as an emergent clinical problem for at least two decades (Percival et al, 2012; Song et al, 2016). As opposed to infections caused by planktonic bacteria that respond relatively well to standard antibiotic treatment, bacteria that form biofilms tend to cause chronic infections that persist despite adequate antibiotic treatment. Biofilms are usually formed by multiple different bacteria, among which *Pseudomona aeruginosa* and *Staphylococcus aureus* resistant (MRSA) or sensitive (MSSA) to methicillin are the most commonly found (Burmolle et al, 2010). On the other hand, an aerosol spray of silver sulfadiazine, lidocaine and vitamin A has been reported to have a strong anti-biofilm effect against biofilms of these so-called 'super bacteria' (Moyano et al, 2020).

The authors' early clinical experience of the topical treatment of SPU with a novel aerosol formulation of silver sulfadiazine is presented in this article.

Answer the following questions by choosing a single option. To confirm an option, mark the box with a cross (X)

Which group do you belong to?

Medical Staff ☐

Nursing Staff ☐

Which wound dressing method did you find the easiest to apply?

Silver sulfadiazine, lidocaine, and vitamin A aerosol ☐

Conventional methods of healing ☐

Which healing method do you find is more practical?

Silver sulfadiazine, lidocaine, and vitamin A aerosol ☐

Conventional methods of healing ☐

Which wound dressing method is best suited to the scalp?

Silver sulfadiazine, lidocaine, and vitamin A aerosol ☐

Conventional methods of healing ☐

How satisfied are you with the application of Silver sulfadiazine, lidocaine, and vitamin A aerosol over conventional wound dressing methods?

Satisfied ☐

Very satisfied ☐

Dissatisfied ☐

Figure 2. Satisfaction survey on SPU wound dressing methods.

Material and methods

This was a prospective case series of patients who received treatment for SPU with an aerosol formulation containing silver sulfadiazine, lidocaine and vitamin A (Platsul- A® aerosol, Soubeiran Chobet, Buenos Aires, Argentina) every 12 hours. Treatment consisted of wound cleansing, aerosol application and occlusion with sterile gauze. Inclusion criteria were bedridden patients, admitted to the ICU with SPU at any stage. All patients were rotated every 2 hours (when possible) as part of a pressure relief system. Terminal patients that had another dermatological pathology on the scalp or with a traumatic or acute wound on the scalp were excluded from the study.

For each patient, measurements of ulceration evolution, signs of infection and easiness of treatment were measured. Evolution of each SPU was measured with pictures and a ruler on the affected area every 48 hours *[Figure 1]*. In order to determine the total wound area, images were analysed using the Informatic Image System J (US National Institute of Health). Biopsies for microbial culture were done only in cases with clinical signs of local infection of the wound. Follow-up and data recollection were completed during the entire patient's ICU stay.

Additionally, medical professionals who performed the treatments were surveyed about the ease of use and satisfaction. The survey model is presented in *Figure 2*.

Table 1. Base characteristics.

Patient	Sex	Initial ICU diagnosis	Age	Ulcer (PU) initial	Hospitalisation days	PU initial surface area (cm^2)	
1	Female	Burned	99	II	14	4.719	
2	Male	Pulmonary fibrosis	57	IV	22	3.801	
3	Male	Aortic aneurysm	72	II	5	4.757	
4	Male	Acute coronary syndrome	86	II	14	8.961	
5	Male	Polytrauma	41	I	21	3.000	
6	Female	Liver transplant	70	II	8	2.986	
		Average	**70.8**	**Average**	**14.0**	**Average**	**5.00**
		Standard deviation	**20.5**	**Standard deviation**	**6.8**	**Standard deviation**	**2.91**
		Median	**71.0**	**Median**	**14.0**	**Median**	**4.72**

Table 2. Results: Final stage and Surface area of PUs during treatment with aerosol silver sulfadiazine, lidocaine, and vitamin A.

Patient	Final stage	PU initial surface area (cm^2)	PU final surface area (cm^2)	PU initial surface area (cm^2) - PU final surface area (cm^2)		PU reduction during ICU stay (%)	PU % reduction per day
1	II	4.719	1.611	3.108	0.22 cm^2/day	65.86%	4.7%/day
2	II	3.801	0.826	2.975	0.14 cm^2/day	78.27%	3.6%/day
3	II	4.757	2.418	2.339	0.47 cm^2/day	49.17%	9.8%/day
4	II	8.961	6.734	2.227	0.16 cm^2/day	24.85%	1.8%/day
5	I	3.000	0.000	3.000	0.14 cm^2/day	100%	4.8%/day
6	II	2.986	1.800	1.186	0.15 cm^2/day	39.72%	5.0%/day
				Average	**0.21 cm^2/day**	**59.65%**	**4.9%/day**
				Standard deviation	**0.13 cm^2/day**	**27.32%**	**2.7%/day**
				Median	**0.15 cm^2/day**	**30.35%**	**4.7%/day**

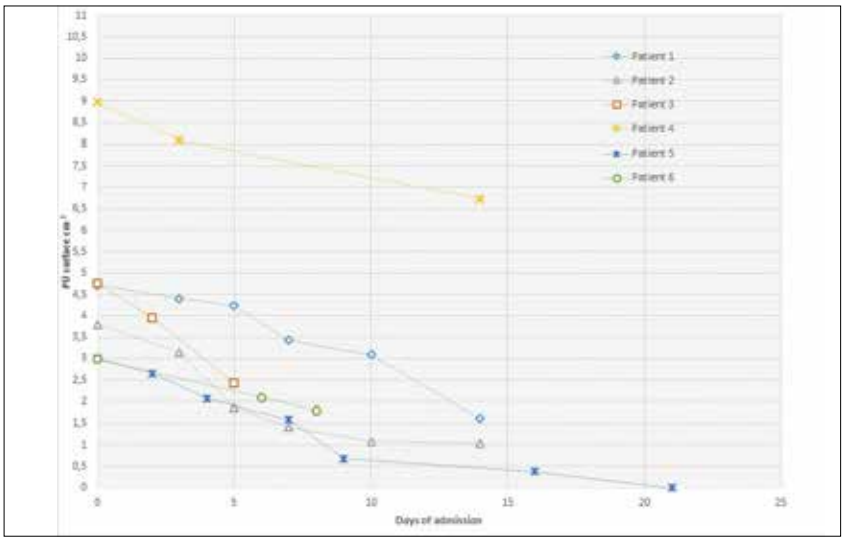

Figure 3.Surface area of PUs during treatment with aerosol silver sulfadiazine, lidocaine and vitamin A.

Results

This observational case series was carried out between August to October 2020. Six patients, two females and four males, were treated and included in this study. Average age of included patients was 70.8 ± 20.53 years (range 41–99; median 71). Average hospital stay at the ICU was 14 ± 6.78 days (range 22–5, median 14). Demographics and base data are presented in *Table 1*.

With the application of an aerosol containing silver sulfadiazine, lidocaine, and vitamin A, none of the six patients treated showed clinical signs of local infection or presented the progression of the PU to a more critical stage. One patient had a favourable evolution from stage IV to stage II during the 22 days of admission. In all patients, the SPU decreased at an average rate of 0.21 cm^2/day. On average, 1.3 ml of the formula was used per treatment on each patient. The daily average reduction of the PU area was 4.9% *[Table 2 & Figure 3]*.

Based on these findings, the six patients experienced enhanced speed of recovery and reduced manipulation of the wound; the authors see these results as key advantages of this approach. There were no reports of adverse effects in any patient.

All medical professionals (four doctors and 12 nurses) who participated from the study

and were surveyed mentioned the easiness of the procedure, if compared to the traditional way of using topical ointments. It was never necessary to change the bed linens, clean the surrounding area, or to remove stains resulting from the product.

Discussion

SPUs are injuries compromising the skin of the head and/or underlying tissue that develop most often on the occipital region. They tend to occur in older people, during the stay in an ICU, or in those who suffer conditions that affect mobilisation. SPUs can emerge rapidly and be very slow to heal. Due to these issues, management remains challenging. Although nurses working in these units are highly trained in PU prevention. It is, unfortunately, fairly common to admit patients with a PU in progress. Standard care involves offloading of pressure, prevention of infection and providing an adequate wound healing environment (Mervis and Phillips, 2019).

Offloading of pressure from the ulcer counteracts the primary underlying aetiology. Although this is the most essential component of treatment, it is also necessary to avoid the development of a new PU. The thin scalp at the occiput is exposed to greater stress values if the patient maintains the same position for extended time. Early mobilisation has been proven to promote function recovery, and to reduce the duration of assisted mechanical ventilation, length of stay and mortality (Kress, 2009). Different devices have been used to promote good position of the head, reducing the occurrence of PUs, not only in the scalp but also in the ears (Katzengold and Gefen, 2018; Werthman et al, 2019).

Furthermore, dressings should promote a moist wound healing environment. Various topical agents or dressings have been used as part of ulcer prevention and management strategies. The development of an aqueous spray formulation of silver sulfadiazine demonstrated the equivalent microbial activity compared with other formulas in an *in vitro* study. (Bhadra and Gajera, 2016). The silver nanoparticles contained in the spray can affect a wide range of aerobic and anaerobic microorganisms, reduce the necrotic tissue amount and, consequently, eliminates necrotic tissue in the wound (Mishra et al, 2008). Topical spray of silver sulfadiazine is a novel method used without touching the surface treated, causing less pain or a reduced chance of contamination or spread of infection at the site of wound. It also avoids the necessity of using sterile gloves for applying topical antibiotics and maceration of the surrounded skin when an ointment layer is applied. Side effects of silver sulfadiazine are uncommon and generally of mild compromise. However, allergic reactions can occur in patients with a known sulfa allergy (Fuller, 2009).

This small group of patients has shown promising outcomes using an aerosol formula of silver sulfadiazine, lidocaine and vitamin A. Results demonstrated reduction of biofilm formation, promoting in this way the wound healing rate of 0.21 cm^2/day, which is indeed faster than previously reported rates using hydrocolloids (0.14 cm^2/day for PU stages II and III) and gauze (0.078 cm^2/day for PU stages I and II) (Capillas Pérez et al, 2000). Re-epithelialisation rate in our study was 4.09%/day, which is also faster if compared to rates reached in wounds treated with autologous skin cells (1.58%/day) or hydrocolloid dressings (1.09%/day) (Hu et al, 2017). Chronic bacterial contaminations can slow or halt the healing of SPUs, and bacterial load is negatively correlated with the healing rate (Browne et al, 2001).

Therefore, the authors hypothesised that biofilm control is a key aspect when treating SPUs. Although this study is based on a reduced number of cases, the authors believe that biofilm control might be a more determinant factor in the healing of a chronic wound than, for instance, the use of cellular growth factors (Bhadra and Gajera, 2016; Werthman et al, 2019).

ICU patients are usually bedridden and immobilised, which hinders SPU treatment. Based on our observations, we propose that the aerosolised combination of silver sulfadiazine, lidocaine and vitamin A is well-suited to the treatment of ICU patients. Thus, the problems that a topical treatment of SPU of patients admitted to the ICU is avoided.

All medical and paramedical professionals participating in this study noted the simplicity and speed of this novel aerosol treatment, which is much cleaner if compared to the use of ointments. The surrounding areas remain clean, including the bed linen and the patient's hair. The formula within the device also remains sterile because of the aerosol mechanism and, thus, a single aerosol device can be used for multiple ICU patients.

An alternative treatment option for SPU is the use of hydrocolloid dressings. In our experience, although such dressings are effective in the treatment of PUs, the cost can be relatively high, if we take into account that a PU treatment can require a daily change of dressing (US$8.24 per

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dressing). On average, we used 1.3 ml of the formulation per application, which is equivalent to 2.6 mm/day/patient (US$1.45 per day). Based on these data, the use of the aerosol silver sulfadiazine formulation is significantly cheaper than hydrocolloid dressings.

Conclusions

Although this observational prospective study only includes a limited number of cases, the findings can be considered promising. The tested novel aerosol formulation of silver sulfadiazine seems a favourable approach for treatment of SPU in patients admitted to an ICU. Ease of application and saving costs are key advantages of the silver sulfadiazine aerosol. These encouraging preliminary results should be followed up with further larger controlled studies to confirm the authors' findings. WINT

Conflict of interest

The authors declare no conflict of interest.

Ethics approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The local research ethics committee approved this study.

Informed consent to participate

Informed consent was obtained from all the participants included in the study.

Patient consent

Patients signed consent regarding publishing their data and photographs.

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