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Impact of a pain protocol including hypnosis in major burns

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ARTICLE INFO

Article history:
Accepted 23 August 2009

Keywords:
Critically ill
Major burn
Pain
Outcome
Economic assessment
Morphine

ABSTRACT

Background: Pain is a major issue after burns even when large doses of opioids are prescribed. The study focused on the impact of a pain protocol using hypnosis on pain intensity, anxiety, clinical course, and costs.

Methods: All patients admitted to the ICU, aged >18 years, with an ICU stay >24 h, accepting to try hypnosis, and treated according to standardized pain protocol were included. Pain was scaled on the Visual Analog Scale (VAS) (mean of daily multiple recordings), and basal and procedural opioid doses were recorded. Clinical outcome and economical data were retrieved from hospital charts and information system, respectively. Treated patients were matched with controls for sex, age, and the burned surface area.

Findings: Forty patients were admitted from 2006 to 2007: 17 met exclusion criteria, leaving 23 patients, who were matched with 23 historical controls. Altogether patients were 36 ± 14 years old and burned 27 ± 15%BSA. The first hypnosis session was performed after a median of 9 days. The protocol resulted in the early delivery of higher opioid doses/24 h ($p < 0.0001$) followed by a later reduction with lower pain scores ($p < 0.0001$), less procedural related anxiety, less procedures under anaesthesia, reduced total grafting requirements ($p = 0.014$), and lower hospital costs per patient.

Conclusion: A pain protocol including hypnosis reduced pain intensity, improved opioid efficiency, reduced anxiety, improved wound outcome while reducing costs. The protocol guided use of opioids improved patient care without side effects, while hypnosis had significant psychological benefits.

1. Introduction

Pain is a major problem after burns [1]. It is one of the patients' most serious and persisting complaints. Adequate pain control is therefore of utmost importance. A study including patients scheduled for hernia repair, a very standardized wound, showed that pain impairs wound healing [2]: psychological stress impairs the inflammatory response and matrix degradation after surgery. In addition pain and stress contribute to delirium which is frequent in the intensive care unit (ICU) [3,4]. Furthermore acute pain contributes to post-traumatic stress disorder, which is common after burns [5]. Pain during hospitalization is significantly associated with psychological adjustment to the consequences of major burns

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0305-4179/$36.00
doi:10.1016/j.burns.2009.08.009

[6]. In addition, there is an association between acute pain severity and development and maintenance of suicidal ideation in burn patients after discharge from hospital [7].

The treatment of burn pain requires a multimodal approach to treat the acute pain bursts which burden intense continuous pain [8]. The doses of opioid analgesics required for pain control may be very large, and increase the risk of side effects [1,9]. Most published pain studies use pharmacological agents, and exhibit a significant failure rate [10]. Anxiety is particularly present around various painful procedures, required for wound treatment, such as dressings and hydrotherapy. The importance of nursing procedures in control of pain has recently been stressed as part of this multimodal approach [8].

Supplemental non-pharmacological analgesic techniques can be effective, because pain perception has a strong psychological component. They include mental imagery, video watching, biofeedback, enhanced control, parental participation in children, and hypnosis [8]. The latter has been shown in a few studies to be an important and efficient adjunctive therapy in the treatment of burn pain [1,10]. Recently, randomized trials studied the effect of hypnosis on burn pain [9,11,12], but to our knowledge, none of them has been conducted in a critical care setting. The reports consistently show that using hypnosis early in burns care may have a number of benefits [13]. Some showed that hypnosis can be used easily in a busy medical intensive care unit environment [13], and help reduce opioid requirements [14]. More recent evidence based publications have shown that hypnosis helps to control burn pain [12,15], encouraging the clinical use of this technique.

To improve pain treatment in our burn ICU, we based our observations on patient complaints after discharge and the emergence of chronic pain syndromes in a few patients. A quality program was initiated to change clinical practice and to standardize pain management. It was decided to address simultaneously the pharmacological and psychological treatments by including hypnosis in the new protocol. The latter has been shown to reduce opioid requirements [14] and to be applicable over a reasonably short period of time [9,16].

The present study aimed at measuring the influence of the new pain management including hypnosis in a critical care setting on pain intensity, and the patients' anticipation of pain before treatments. The study also aimed at displaying pain level and opioid doses in the computer system, attempting to make pain ''visible on the screen'' for the intensive care physicians and nurses. Finally, the issue of cost was also addressed, since adjunct hypnosis has been shown to be cost-saving during radiologic procedures [17].

2. Patients and methods

2.1. Setting

The burn ICU of a University teaching hospital (CHUV) in Lausanne between 2002 and 2007. The 4 burn beds are included in the 32 bed multidisciplinary ICU facility.

The ICU is organised as follows: nurses are in charge of pain evaluation and report it in the computerized information system. Opioids are delivered according to the doses prescribed by the ICU physicians in charge of medical care, using prescription target (e.g. target = VAS $<$ 4, morphine 3 mg/h plus 2 mg morphine reserve qd 1 h). Psychiatrists assess every patient as soon as recovery allows verbal communication: they do not prescribe drugs. Surgeons are in charge of the wound treatments (dressings, hydrotherapy, debridements and grafting). Twice weekly meetings of the complete team with the senior burn specialists (MMB, WR) focus on treatment coordination: pain treatment is specifically addressed. Overall patient management was conducted according to ICU protocols for resuscitation, feeding, metabolic management [18], and antibiotherapy.

2.2. Patients

The study was conducted between 2002 and 2007, with the patient's oral consent and the Institutional Ethics Committee's approval. The inclusion criteria were: age $>$18 years, ICU stay $>$24 h, and agreement to try hypnosis. The ''early'' exclusion criteria were ICU admission more than 24 h after injury, life expectancy $<$48 h, or patient refusal. Delirium developing during ICU stay, or active delusional psychosis, if identified before hypnosis was attempted, were ''late'' exclusion criteria. A psychiatrist (registrar expertise level) assessed the patient before hypnosis, in a structured clinical interview. Delirium was categorized according to psychomotor behavior: hypoactive delirium characterized by decreased responsiveness, withdrawal, and apathy, or hyperactive delirium characterized by agitation, restlessness, and emotional lability [19].

The intervention patients were enrolled prospectively between May 2006 and April 2007. The matched controls were admitted between 2002 and 2006: their data were prospectively collected into the ICU's computerized data base (MetaVision®, iMDsoft, Tel Aviv, Israel). Matching of patients was based on sex, age, and burned body surface (% body surface area burned = BSA). The derived burns' scores were calculated: the Ryan score including age, burn size and inhalation injury [20], and the abbreviated burn injury index [21]). The severity of the physiological alterations during the first 24 h in the ICU was summed by the Simplified Acute Physiology Score (SAPS II) [22]. Physiological variables were recorded according to the standardized nursing techniques of the ICU. The observations were limited to 40 days after injury.

2.3. Intervention

2.3.1. Pain management

During the first days after injury, pain treatment was based on standardized opioid prescription aiming at a pain score VAS $<$ 4 (see definition below). Pain assessment and therapy were systematically addressed by physicians and nurses during clinical round. During both periods, the nurses were in charge of delivering opioids based on a combination of continuous infusion plus bolus reserves. Pain assessment was carried out by nurses most of the time, and recorded in the system. The staff was globally stable during the study period. The differences in pain management between the 2 periods are summarized in Table 1.

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Table 1 – Comparison of pain management during the two study periods.

Variable	Historical	Intervention
VAS scoring	Yes	Yes
VAS target	Not specified	VAS < 4
Opioids	Morphine, fentanyl, Methadone	Morphine, fentanyl, methadone, hydromorphone, oxycodone
Opioid rotation	Not mentioned	Encouraged
Reserve opioids	Yes	Yes
Systematic pain discussion during the round	No	Yes
Customized computer page	No	Yes

Opioid rotation consists in changing to another opioid, in the event that pain is not controlled, or is associated with oversedation, or the patient presents signs of toxicity such as delirium, agitation, or myocloni [23]. In that case, an equivalent opioid dose is calculated, and half this equivalent dose of the second opioid is then prescribed with reserve doses to enable adaptation to VAS < 4 by the nurse. Opioids used were morphine, fentanyl, hydromorphone, methadone and oxycodone. For painful procedures (dressing and hydrotherapy), opioid and sedative delivery was standardized to fentanyl and propofol, and was administered by the anaesthesiologist. Pain therapy recording was the same over the two periods (pain and sedation scores, as well as the opioids and sedatives used in the ICU), with the addition of the ESAS score (see below) and of hypnosis sessions in the intervention group. Burn specific procedures have been customized since 2000 (Fig. 1).

2.3.2. *Hypnosis*

Hypnosis was proposed to the patients as soon as possible, i.e. on admission or as soon as they were extubated and mentally alert. A learning time was required until patients could achieve a trance level and an adequate level of comfort: during this preparation period the painful procedures were carried out under anaesthesia or analgesia and sedation. Hypnosis was administered by an ICU nurse who had completed 3 years of training, under supervision of a psychiatrist. There was no blinding of any of the participants to the ongoing procedure, nor to the medications.

Hypnotic induction and specific suggestions and details during the course of induction varied according to the nurse's observation of the patient's behaviour, and on her judgement of the patient's needs. In 76% of cases induction used the cenesthesic approach (patient attention focused on any body sensation), while in cases of acute pain or anxiety (34%), induction was carried out on the actual symptom.

Typically, there are five stages in classical hypnosis: setting the stage, slowing of breathing and relaxation, suggestion for deepening of relaxation and hypnosis, suggestion for pain control, and alerting [12]. An adequate level is reflected by slow breathing and patient's description of being in a ''safe place'' [24]. Hypnosis level was assessed by the hypnosis nurse (MD), based on possibility to carry out the procedure.

2.4. *Measurements and outcome variables*

Physiological variables (heart rate, blood pressure) were recorded before, during and after the painful procedures.

The *Visual Analog Scale (VAS)* is a self-rating method using a 10-cm device to assess the level of pain which presents as a ruler or a thermometer (0, no pain; 10, worst pain ever) [25,26]: it has been shown to be a useful instrument for measuring pain in burned patients. It was administered and recorded at least 4 times per day to record basal pain, and repeated up to 12 times in case of acute pain, whether related to a painful procedure such as a dressing change or not (see below ESAS for procedural pain evaluation). Maximum pain was recorded, as well as pain at the end of procedure. A mean VAS score for every day in the ICU was

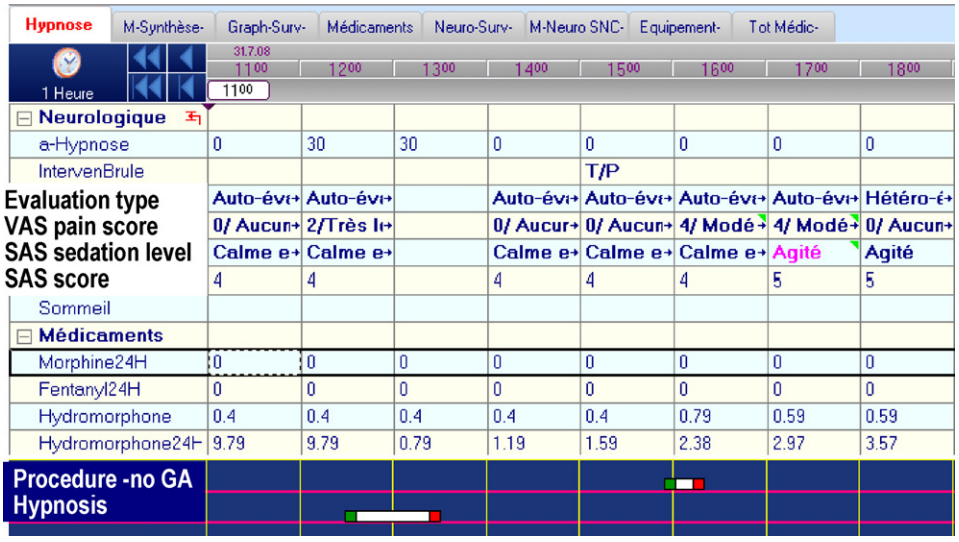

Fig. 1 – Dedicated sedation and pain monitoring screen in the computerized system showing the pain score (VAS), sedation score (SAS = Sedation Agitation Score [36]), and the current doses of opioids and sedatives along with the procedure carried out during the day (GA = general anaesthesia), and hypnosis session.

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documented. We used the VAS and not a burn specific scale [27] as our patients are treated in a mixed ICU: including different assessment tools would increase confusion among nurses.

The *Edmonton Symptom Assessment Scale* (ESAS) is a 9-item patient-rated symptom VAS developed for use in assessing symptoms of patients receiving palliative care which has been validated in cancer populations. The nine symptoms are: pain, activity, nausea, depression, anxiety, drowsiness, lack of appetite, well-being, and shortness of breath on a 10-cm scale [28]. The ESAS was used before and after any hypnosis session or any painful procedure under hypnosis in the intervention group, to assess patient's related symptoms.

Opioid requirements. The different opioids were converted into morphine equivalents using a web-based dose converter to enable comparison of requirements [29]: the first 40 days after injury are included in the analysis as 85% of patients were discharged from the ICU. The computer system summed up all doses of opioids delivered to the patients. The basal ''non-procedural'' 24 h opioid requirements (which was the sum of continuously delivered opioids and of reserve boluses) and the procedural opioid delivery doses were recorded separately: they were summed to determine the total 24-h opioid dose.

Psychological management. Systematic psychiatric assessment belonged to the protocol, and the number of consultations was recorded. A questionnaire was developed and applied at the end of the ICU stay to address patient's procedural perception (i.e. for dressings and hydrotherapy) and memories at the end of the hospital stay with the following questions: was the procedure agreeable (y/n), comfortable (y/n), how was comfort after procedure (1–10), maximum intensity of pain (tolerable, strong, and unbearable), anxiety (y/n), confusion (y/n).

Wound management was standardized. Hydrotherapy was carried out in a dedicated room before the first surgical session and after post-surgery day 5. Dressings were carried out either in the patients' room or in an operating room. Early scar excision was started within 72–96 h, by 10–15% BSA steps, 1–3 times weekly. Wound healing was assessed by comparing the total surface requiring surgery and the sum of the surface effectively grafted during the successive sessions. We recorded the number of procedures carried out under anaesthesia, as well as the duration of each procedure.

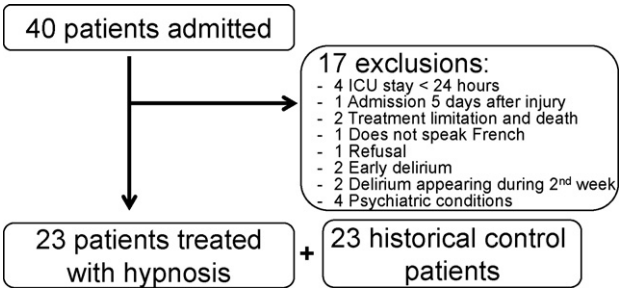

Fig. 2 – Enrollment diagram.

Economic assessment. Cost data were retrieved from the analytic accounting system, which singled out the direct cost for one ICU day (€1740) and a standard hospital ward (€440) as well as the cost of 1 anaesthesia session of 70 min for dressing change (€500). The wages of the hypnosis nurse amounted to €74,660 for a full time employment (FTE) in the ICU and €69,325 in the standard ward.

Statistics. Data were prospectively recorded in the computerized information system. Data are provided as mean ± S.D., median and range. Comparison of baseline continuous variables between groups were carried out with one-way ANOVA, and non-parametric variables with χ^2 tests (e.g. opioid rotation), or Wilcoxon test (VAS levels). Two-way ANOVA was used to analyse evolution of opioid dose delivery over time. The assessor was MMB, who received blinded files that had been constituted by MD. MMB was blinded to the grouping at the time of statistical outwork: the code was broken thereafter. Significance was considered at p level <0.05, while trends were considered up to $p = 0.20$. Statistical package was JMP® Version 5.5., SAS Institute Inc., Cary, NC, USA.

3. Results

During the study period, 40 patients were admitted (Fig. 2). Seventeen patients met exclusion criteria: 15 patients had early exclusion criteria, while 2 elderly patients developed delirium and were unable to enter hypnosis sessions. The 23

Table 2 – Patient characteristics.

N patients and observation days	Historical (n = 23/718 days)	Intervention (n = 23/663 days)	p
Age	36 ± 16, 31 [17–68]	36 ± 13, 35 [19–67]	ns
Sex	16 M/7 F	14 M/9 F	ns
BMI	24 ± 5, 23.3 [15.5–37.3]	24 ± 5, 24.2 [15.7–40.2]	ns
Inhalation injury	9/23 (39%)	12/23 (52%)	ns
Burned %BSA	27 ± 15, 25 [7–70]	27 ± 16, 25 [5–60]	ns
Surgical %BSA	15 ± 13, 12 [0–45]	14 ± 14, 10 [0–51]	ns
SAPS II	26 ± 10, 25 [10–53]	23 ± 10, 23 [10–40]	ns
Ryan score	0.7 ± 0.6, 1 [0–2]	0.9 ± 0.7, 1 [0–2]	ns
ABSI	7 ± 2, 7 [3–10]	7 ± 2, 8 [3–10]	ns
Proportion of surgical burn grafted (%)	158 ± 85, 119 [100–421]	99 ± 46, 100 [0–167]	0.014
Length of mechanical ventilation (days)	8 ± 10, 4 [0–34]	6 ± 6, 5 [0–15]	ns
Length of ICU stay (days)	28 ± 29, 21 [2–140]	21 ± 19, 16 [1–79]	ns
Length of hospital stay	43 ± 35, 39 [4–166]	37 ± 33, 28 [2–148]	ns

Data in mean ± S.D., medians [ranges]. BMI: body mass index; ABSI: abbreviated burn severity index; SAPS: Simplified Acute Physiology Score.

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Table 3 – Opioid and sedative requirements for the painful procedures.

	Historical ($n = 23$)	Intervention ($n = 23$)	p^*
Hypnosis sessions	–	101	
Time to first session (day)	–	8 ± 7, 9 [0–20]	
Procedures in the ICU (n)	150	171	ns
With anaesthesia	142 (95%)	127 (74%)	<.0001
Duration (min)	140 ± 72, 120 [25–425]	127 ± 76, 75 [35–405]	0.053
Fentanyl requirement (mg)			
Before hypnosis	565 ± 340, 500	470 ± 240, 500	ns
With hypnosis	–	80 ± 65, 75	<.0001
Propofol requirement (mg)	380 ± 340, 240	0	<.0001
ESAS			
Before hypnosis	–	22 ± 15, 20 [0–62]*	
After hypnosis	–	13 ± 11, 8 [0–48]*	<0.0001*

Data in mean ± S.D., median [ranges]. VAS: Visual Analog Scale; ESAS: Edmonton Symptom Assessment Scale. Procedures - dressing and hydrotherapy.
* Refers to a difference "within" the hypnosis group: i.e. before and after the hypnosis session.

hypnosis patients were studied prospectively, and compared to 23 matched control patients (Table 2). Altogether 46 patients were analyzed during 1381 days including 939 ICU treatment days. Age, gender ratio, burned body surface, inhalation injury did not differ between groups. The proportion of patients with second degree burns not requiring surgery was similar in both groups. All the patients were discharged alive: six patients were lost to follow-up (four moved to another country, one was institutionalized, and one refused to participate).

Clinical variables (Table 3). There was no significant change in heart rate, arterial pressure, and respiratory rate during the painful procedures between groups. The times to first bowel movement (5 [2–11] days in historical controls versus 4 [1–8] days in intervention group) and to first mobilization (6 [0–58] days in historical controls versus 7 [0–28] days in intervention group) were unchanged as they generally occurred before hypnosis treatment could be introduced. Importantly, the larger doses of opioids were not associated with more intestinal complications. The mean lengths of ICU and hospital stays were not significantly shorter in the intervention group.

Hypnosis. The first session could be carried out on a median of 9 days after injury (range 0–20 days), eight patients having their first session on admission day. A median of three sessions of training per patient were required to enable facing painful procedures. A hypnotic trance level was achieved after a median of 15 min.

Pain intensity. The mean VAS daily score was significantly reduced in the intervention group from 1.4 ± 1.7 to 0.9 ± 1.3 points ($p < 0.0001$) throughout the stay (Fig. 3). The elevated number of daily observations ($n = 1381$ from D1 to D40) is not readily visible on the figure, but the very high pain scores are significantly more frequent ($p = 0.021$ by Wilcoxon test) in the historical group, and are not simply isolated outliers.

ESAS. This score was only used in the intervention group before and after the hypnosis sessions. The latter global score was significantly reduced (Table 3). Individual items changed as follows: anxiety was significantly reduced from 3.2 ± 2.9 to 1.2 ± 1.7 points ($p < 0.0001$); depression feeling was reduced from 1.8 ± 2.5 to 1.0 ± 1.6 points ($p = 0.014$); well-being (best = 0) was improved from 3.7 ± 2.5 to 1.2 ± 1.5 points ($p < 0.0001$); drowsiness was reduced from 3.9 ± 2.85 to 2.7 ± 2.3 points ($p < 0.014$); pain (VAS) was reduced from 2.5 ± 2.6 to 0.9 ± 1.4 points, $p < 0.0001$; nausea and lack of appetite were unchanged. The amount of psychiatric interventions was lower in the intervention group with 2 ± 5 versus 6 ± 8 ($p = 0.07$).

Opioid requirements. During the first 10 days, mean daily opioid doses were significantly higher in the intervention group compared with historical controls ($p < 0.0001$). Within the intervention group the overall opioid delivery was higher in those patients who could not benefit from early hypnosis ($n = 15$) compared with those benefiting from hypnosis on admission, without any detectable side effects (Fig. 4). Thereafter, the doses of opioids required for pain control were significantly reduced. Between days 10 and 15 (gap in Fig. 4), the doses of opioids declined in both groups and in most patients, as the result of pain decreasing after the first surgeries and wound healing. This decrease of opioid delivery

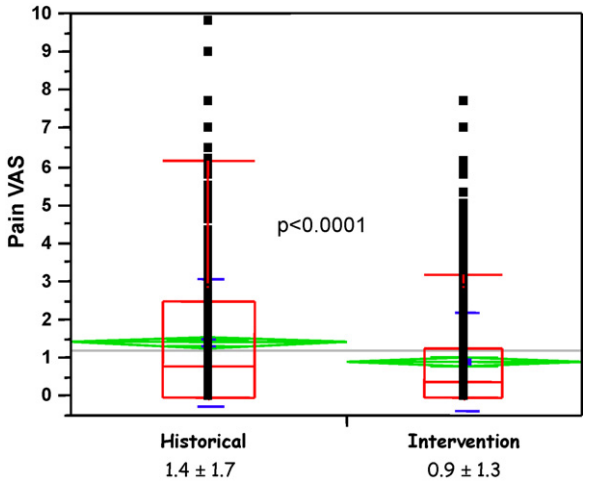

Fig. 3 – Daily VAS pain score during the first 40 days: there was a significant reduction of mean VAS score in the intervention group.

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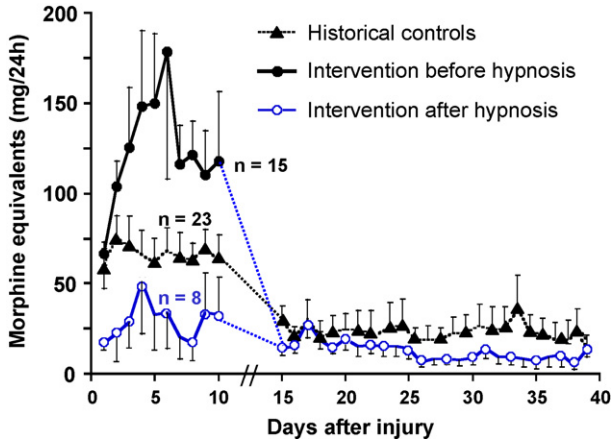

Fig. 4 – Evolution of opioid requirements. In the intervention group the doses of opioids required for pain control were significantly higher ($p < 0.0001$) in the 15 patients who had not benefited from early hypnosis compared to the requirements in the 8 patients benefiting from very an early hypnosis intervention (during the first 24 h of admission). The doses were also much higher than those delivered in the patients of the historical group ($p < 0.0001$). After day 15, the opioid requirements in the intervention group remained significantly lower than in historical controls.

was very small in the eight intervention patients having benefited from early hypnosis sessions, as their opioid requirements were low from the start. After day 15, the mean daily non-procedural and procedural opioid doses remained significantly lower in the intervention group ($p = 0.001$).

Procedural opioid and sedative requirements were similar in both groups before hypnosis introduction. In the intervention group, the procedural opioid (fentanyl) and sedative (propofol) requirements were strongly reduced after introduction of hypnosis ($p < 0.0001$) (Table 3).

Opioid rotation was carried out in 13 patients, once per patient as a median (0.8 ± 0.7 rotations, range 0–2) in the intervention group, versus in only 5 patients in the historical group (0.2 ± 0.4 rotations, range: 0; $p = 0.004$; $p = 0.018$ for the number of patients benefiting from rotation in both periods). The first opioid rotation was carried out between days 3 and 14 (mean after 7.8 ± 3.4 days). Recorded reasons for opioid rotation were increasing doses of opioids (doses >140 mg morphine per day) with unsatisfactory analgesia (i.e. a VAS > 4), or oversedation.

Patient questionnaires were available in 21/23 patients in the hypnosis and 19/23 in the historical patients: procedures were perceived as agreeable in 12/21 in hypnosis versus 0/18 in control ($p < 0.0001$), the patients felt comfortable in 19/21 in hypnosis versus 1/18 in control ($p < 0.0001$), the patients experienced a fair comfort after the procedure in 13/21 in hypnosis versus 0/18 in control ($p < 0.0001$), maximum intensity of pain was considered unbearable 0/21 in hypnosis versus 7/18 in control ($p = 0.001$), while the procedure was anxiety generating in 0/21 in hypnosis versus 15/18 in control ($p = 0.02$). The number of psychiatric consultations during the ICU stay was reduced from 5.6 to 2.1 per patient ($p = 0.07$).

Wound healing. The total grafting requirements were significantly lower ($p < 0.014$) in the hypnosis group (Table 2), while the number of surgical sessions did not differ significantly (median two sessions in the hypnosis versus three in the control group). While total number of procedures did not differ between the two periods, the number performed under general anaesthesia was significantly reduced from 143/150 (95.3%) in the control group to 127/171 (74.2%) in the intervention group ($p < 0.0001$).

Economic assessment. Hypnosis therapy was associated with a non-significant 5 days shorter mean ICU length of stay (LOS) and a 6-day shorter mean ward LOS, as well with avoiding a mean of 2 anaesthesia sessions per patient. Altogether, this strategy resulted in savings of €11,340 per patient in hospital stay (ICU €8710 and ward €2630) and €1010 in anaesthesia sessions, amounting to a total of €12,345 or €283,965 for the whole sample of 23 patients. Additional costs for the hypnosis nurse amounted to €74,660 in ICU (1.0 FTE) and €34,665 in ward (0.5 FTE), resulting in total additional costs of €109,325 per year. The net savings thus amounted to €174,640 per year. Economic balance would be reached by treating nine patients per year with hypnosis therapy.

4. Discussion

The present study shows that a protocol in pain management including hypnosis reduced patient anxiety and exposure to pain, increased early opioid delivery, and decreased general anaesthesia requirements, hospital length of stay and costs.

In pain management, larger doses of opioids were delivered in response to increasing VAS scores during the first days after admission, followed by significantly lower doses after the introduction of hypnosis. The patients' pain intensity assessment according to the VAS was lower throughout in the Intervention group, reflecting the combined benefit of more liberal and adequate opioid delivery and hypnosis. The better pain control was associated with improved clinical course as reflected by lower surgical grafting requirements, lower number of procedures under anaesthesia, and less frequent interventions of the psychiatric team.

This is to our knowledge the first hypnosis study conducted in an ICU in which attending physicians frequently have a limited training in the treatment of severe pain. A target of VAS < 4, and the daily scores are easily visualized on the computer system, with the simultaneous visualization of the total daily opioid dose facilitated analgesic prescription and adaptation. Pain level change has become ''measurable and quantifiable'' based on this visualization of the variables required for pain control (Fig. 1). This has reduced subjectivity, and enabled immediate decisions about analgesia and sedation by the multidisciplinary team (intensive care, anaesthesia, plastic surgery, psychiatry). The awareness of the pain issue resulted in a significant increase of the doses of opioids delivered during the first 10–15 days after admission to the ICU. These higher doses did not increase the incidence of side effects, probably due to the introduction of systematic monitoring and of opioid rotation: the latter was used as a

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median once in the Intervention group. This can be considered a success, and reflects awareness to potential side effects of high doses of opioids [23].

Hypnosis is a state of consciousness highly accessible to suggestions. Both intensity and unpleasantness of the noxious stimuli are reduced by suggestions during the hypnotic state [30,31]. Although the neural mechanisms remain unclear, recent studies support the involvements of the anterior cingulate cortex and primary somatosensory cortex (S1) in affective and sensory aspects of pain perception, respectively. Pain, and particularly burns, causes stress with intense physiological responses, including sympathetic activation with catecholamine release, release of stress hormones, alteration of immune function, and behavioural changes [32,33]. The factors modulating the different components of this response are many, and despite a clear cut reduction of pain levels and opioid requirements, we could not detect any significant change of either heart rate of blood pressure [18], in accordance with previous research showing that physiological parameters are not good outcome markers in pain assessment [8].

Anxiety before the procedures was frequently recorded in the historical controls: we therefore attempted to quantify this symptom. The ESAS was chosen for assessment of anxiety as a result of the collaboration with the palliative care team: it provides a 10-point scale for each symptom. The intervention patients expressed less anxiety before the procedures, considering even the hydrotherapies as agreeable – this strongly contrasted with the experience of the control patients, whose anxiety before the procedures was enormous despite anaesthesia: clearly the acute stress disorder was reduced. Obviously, hypnosis had a strong impact. The present study will be followed by a prolonged psychiatric follow-up investigating the impact on depression and symptoms of post-traumatic stress disorders which is reported in 29% of burn patients 1 year after the accident [34].

Wound healing was improved in the intervention group as reflected by the lower grafting requirements. This may be accounted for by lower stress levels as shown in a study 47 patients undergoing inguinal hernia repair [2]: greater worry predicted lower levels of matrix metalloproteinase-9 in the wound fluid ($p = 0.03$) as well as a more painful ($p = 0.002$), poorer ($p = 0.04$), and slower recovery [2]. Burn recovery can be hindered by the presence of acute pain [35] – in particular pain makes patients dependent on anaesthesia and more complex care. The trend to a reduction in length of ICU stay may be explained by the patients' being ''empowered'' regarding painful procedures as they know they will be able to control pain, having learned to cope with it.

Finally, the economic assessment showed that hypnosis therapy was cost-saving: the number needed to treat was 9 to compensate the investment constituted by the hypnosis nurse's salary. This finding confirms data in interventional radiology by Lang and Rosen [17]. The main impact was the reduction of the length of ICU stay by a mean of 5 days per patient. This reduction, as well as the reduction of 2 anaesthesia sessions per patient, although not significant, are at least partly attributable to the pain management, in absence of other treatment changes during the period. Regarding the reduction of length of stay on the ward, other factors might have played a role, including the collaboration with a rehabilitation unit that was established during the study period.

Several methodological limitations must be considered. First, out of 40 patients admitted during the period only 23 were able to benefit from this treatment showing that hypnosis cannot be used in every patient: delirium is a frequent cause of failure in elderly burn patients in the ICU. In addition patient expectations and the ability to be hypnotised are difficult to predict: the motivation has been shown to be high in burn patients due to the intensity of their pain experience [9]. This does not compromise our results, but shows that hypnosis is not standard care. Second, the study was not randomized as it was a change of practice, which carries its own limitations: matching historical controls for burn size, sex and age in a prospectively collected data base was the only available tool for comparison. We used historical controls which also carries its limitations. Furthermore, the study combined quantitative and qualitative variables, and was not powered for economic data.

In conclusion, a change in pain management including hypnosis in burned patients was associated with significant clinical and psychological benefits. It achieved a better pain control, a more efficient opioid therapy, reduced anaesthesia requirements, improved the patients' procedural perception, reduced anxiety and requirements for psychiatric interventions, and improved wound healing. These changes were associated with an improved clinical outcome as reflected by a reduction of grafting requirements, mean earlier ICU and hospital discharge (trend), and lower costs. These findings open perspectives for including hypnosis in the management of patients suffering from conditions associated with severe pain and requiring multiple interventional procedures.

Conflict of interest statement

None to declare.

Acknowledgements

The authors are grateful to Dr. Claudia Mazzocatto (MD, Service of Palliative Care, CHUV) for advice during the elaboration of the project, to Dr. Catherine Blanc (MD, Department of Anaesthesiology, CHUV) and her colleagues for collaboration during the painful procedures and compliance with the new analgesia protocol, and to Dr. Eric Bonvin (MD, psychiatrist, Hôpital de Malévoz, Monthey) for training and supervision in hypnosis. We also would like to thank Dr. Julien Rossat (MD) for revising the paper.

Funding: The study was supported by internal resources, including a grant from the Institutional Quality Improvement Commission (CHUV), and a grant from the Fondation pour la Recherche en Soins Intensifs – Lausanne.

Contributors: MMB, MD, CM, and NK were co-principal investigators, designed research, undertook research, collected data, analysed data, and wrote the paper. CP, JBW, PM, and WR collected data, analysed data, and wrote the paper. RCH designed research, analysed data, and wrote the paper.

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Please cite this article in press as: Berger MM, et al., Impact of a pain protocol including hypnosis in major burns, Burns (2009), doi:10.1016/j.burns.2009.08.009