BMC Geriatrics

RESEARCH

Open Access

Perioperative pain management intervention in older patients with hip fracture in an orthogeriatric unit. A controlled before/after study assessing an audit and feedback intervention (PAIN-AGE)

Sabine Drevet[1,2*], Bastien Boussat[3], Armance Grevy[2,4], Audrey Brevet[1], Frederic Olive[5], Marion Richard[6], Laura Marchesi[1], Alize Guyomard[3], Caroline Maindet[7], Regis Pailhe[8], Brice Rubens-Duval[8], Pierre Bouzat[6,9], Jérôme Tonetti[1], Catherine Bioteau[1,2], Gaëtan Gavazzi[1,2], Patrice Francois[3] and Prudence Gibert[2,4]

Abstract

Background Postoperative pain delays ambulation, extends hospital stay, reduces the probability of recovery, and increases risk of long-term functional impairment. Pain management in hip fractured patients poses a challenge to the healthcare teams. Older adults are more vulnerable to opioid-associated side effect and it is primordial to minimize their exposure to opioids. Acetaminophen is associated with reduced opioid use so we need to focus on acetaminophen use in first-line analgesia.

Methods We conducted a controlled before/after study to assess the ability of an audit and feedback (A&F) intervention built with nurses to improve the quality of perioperative pain management in older patients hospitalized for hip fracture in an orthogeriatric unit (experimental group) versus a conventional orthopedic unit (no A&F intervention). The primary endpoint was the percentage of patients who received 3 g/day of acetaminophen during the three postoperative days, before and after the A&F intervention. Secondary endpoints included nurses' adherence to medical prescriptions, clinical data associated with patients and finally factors associated with intervention. The significative level was set at 0.05 for statistical analysis.

Results We studied data from 397 patients (mean age 89 years, 75% female). During the postoperative period, 16% of patients from the experimental group received 3 g/day of acetaminophen before the A&F intervention; the percentage reached 60% after the intervention. The likelihood of receiving 3 g/day of acetaminophen during the postoperative period and adhering to the medical prescription of acetaminophen were significantly increased in the experimental group as compared with the control group. The patient's functional status at discharge (assessed by Activities of Daily Living scores) was significantly better and the length of hospital stay significantly reduced after the A&F intervention.

*Correspondence:
Sabine Drevet
SDrevet@chu-grenoble.fr
Full list of author information is available at the end of the article

Conclusion Our controlled before/after study showed that an A&F intervention significantly improved perioperative pain management in older adults hospitalized for hip fracture. Involving teams in continuous education programs appears crucial to improve the quality of pain management and ensure nurses' adherence to medical prescriptions.

Keywords Acetaminophen, Adherence, Hip fractures, Nurses, Pain, Perioperative period, Education, Intervention, Program

Background

Pain management in hip fractured patients poses a challenge to the healthcare teams. Postoperative pain has been identified as an unfavorable prognostic factor [1, 2]. Pain delays ambulation, extends hospital stay, reduces the probability of recovery, and finally increases risk of long-term functional impairment [3]. Pre- and postoperative (perioperative) pain management is based on multimodal analgesia that consists of the use of several analgesic medications and techniques combined with non-pharmacological interventions [4–6]. Multimodal analgesia improves perioperative pain management and reduces analgesic doses leading to a reduction in the incidence of adverse events [7, 8].

Acetaminophen (or Paracetamol) is an effective analgesic for musculoskeletal pain and represents the front-line therapy for the management of pain in the geriatric population, especially during perioperative periods [9, 10]. Acetaminophen is safe despite old age and associated polypharmacy and polymorbidity [11]. Acetaminophen is recommended as part of the multimodal analgesia [4, 12]. It is the only analgesic that brings a morphine-sparing effect compared to other analgesics such as non-steroidal anti-inflammatory drugs [7, 13]. Its systematic administration following a preestablished protocol is preferred to administration on demand [14]. Older adults are more vulnerable to opioid-associated side effect and it is primordial to minimize their exposure to opioids. Acetaminophen increases the efficacy of oxycodone in adults confronted with acute moderate to severe perioperative pain [13]. Acetaminophen is associated with reduced opioid use so we need to focus on acetaminophen use in first-line analgesia [15]. Learned societies recommend assessment, prevention, and management of perioperative pain. Nurses play a crucial role in this perioperative pain management. By providing care to patients, they serve as the essential link between patients and physicians, ensuring the proper implementation of prescribed treatments.

Pain in older adults is historically neglected [16]. The atypical presentation of pain in older adults is one of the limits leading to underdiagnosed and undertreated pain [17, 18]. The lack of knowledge and inadequate pain assessment have been clearly identified as barriers to optimal pain management [19, 20]. In the new era of modernization of analgesic techniques, the adherence to basic analgesic prescription remains poorly described, particularly for older patients hospitalized for a hip fracture [21]. Acetaminophen is the most frequently administered analgesic (28% to 61%) in hip-fractured patients [22, 23]. However, undertreatment with acetaminophen is common [23]. According to a local pilot study, less than 30% of older patients receive the optimum dose of acetaminophen during the perioperative period.

We hypothesize that patients aged 75 years or more (75+) hospitalized for a hip fracture do not receive optimal management of pain in the perioperative period, in particular do not receive optimal acetaminophen treatment. Our multimodal Audit & Feedback (A&F) intervention was to improve the quality of hip fracture pain management in 75+. Our study (PAIN-AGE) was to evaluate the impact of our A&F intervention. The primary endpoint was the percentage of patients who received 3 g/day of acetaminophen during the three postoperative days, before and after the A&F intervention. Our secondary objectives evaluated clinical practices of perioperative pain management, nurses' adherence to medical prescriptions, the impact of the A&F intervention on patients' outcomes and factors associated with intervention.

Methods

Design

We performed a controlled before/after study (quasi-experimental study) to evaluate the impact of an A&F intervention carried out with nurses (Fig. 1).

We evaluated 1/ the impact of the A&F intervention on nurses' practices with acetaminophen distribution and nurses' adherence to prescribed pain medications and 2/ the impact of the A&F intervention on patients' outcomes with complications occurring during hospital stay in a cohort of 75+admitted for hip fracture to an orthogeriatric unit (experimental group). Results were compared with those of a conventional orthopedic unit (control group) with no A&F intervention. The purpose of the control group was to ensure that the changes observed in the experimental group did not result from other organizational elements or from any events occurring between the two periods.

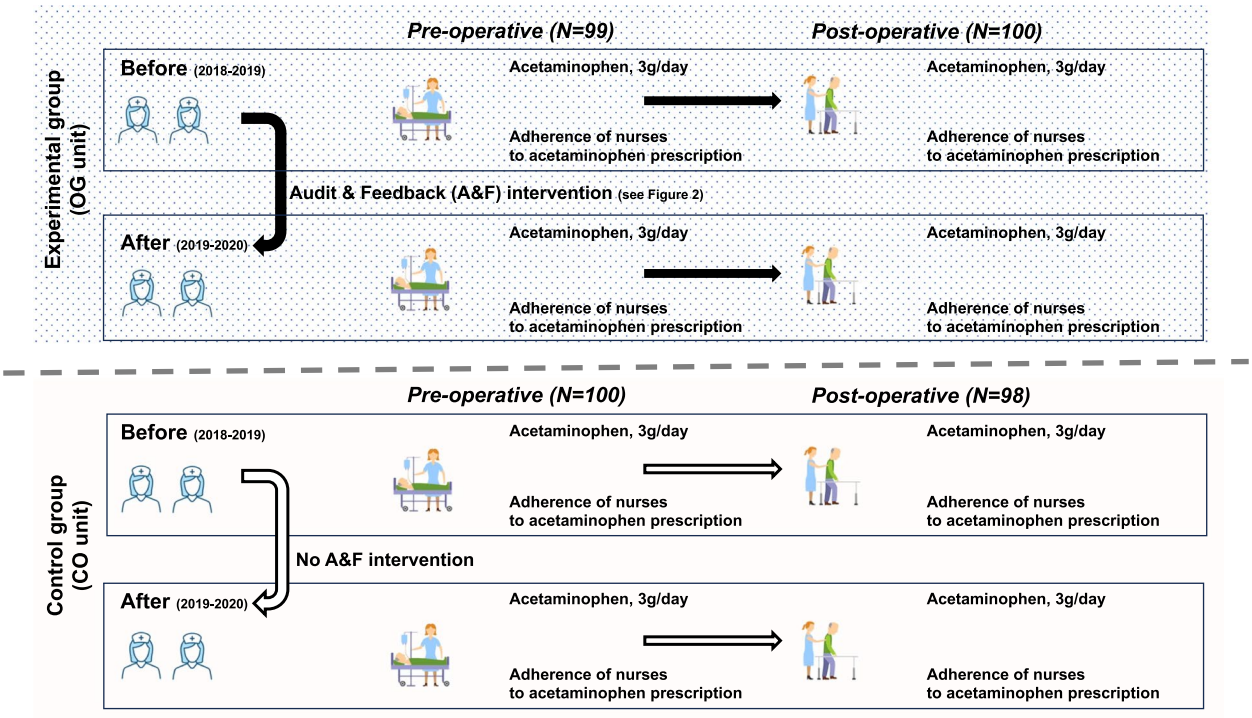

Fig. 1 Study design. We performed a controlled before/after study (quasi-experimental study) to evaluate the impact of an A&F intervention carried out with nurses. Experimental group is represented in the area with till points. Control group is represented in the white area. Before and After concern the period before and after the A&F intervention. Abbreviations: OG: orthogeriatric unit; CO: conventional orthopedic unit

Intervention

A multimodal intervention including A&F was built with nurses [24]. The A&F intervention which included a pre- and post-intervention audit was implemented in the orthogeriatric unit, starting on May 2019 (Fig. 2).

The postintervention audit was associated with feedback. Between the two audits, several practical actions were implemented in the experimental unit. Firstly, healthcare workers were trained on the theme of pain (two 1-h collective sessions) by a medical doctor and the Pain Center nurse. The course included four parts entitled "knowledge about pain" (definition and pathophysiology), "pain assessment and tools", "pain treatment", and "specificity of pain in older patients". The consequences of inadequate perioperative pain management were presented [20]. We used a positive approach of errors. Secondly, a pain assessment scale was distributed. Thirdly, the existing pain management protocol was updated with a specific mention: "give acetaminophen regardless of pain assessment". Fourthly, the medicine staffing was reviewed in collaboration with the clinical pharmacy unit. Fifthly and finally, continuation of care was guaranteed by the implementation of standby night and weekend shift, and the implementation of a medical ward round on Saturday morning. No A&F intervention was implemented in the conventional orthopedic unit (control group).

Setting

The study took place in the Grenoble Alpes University Hospital (France): the orthogeriatric unit was located in the North hospital and the conventional orthopedic unit in the South hospital. The orthogeriatric unit (experimental group) belongs to the orthopedic and traumatological surgery department. It receives patients from the emergency department. There is a daily comanagement between orthopedic surgeons, anesthesiologists, and geriatricians for perioperative care. In this unit, a set of standard pain assessment and management protocols are employed. This set consists of the following: (1) pain assessment through a numerical scale or visual analog scale (VAS) performed systematically 3 times a day and then repeated as many times as necessary; (2) non-pharmacological pain management included during the preoperative period: the limitation of the movements of the traumatized limb by aligning it properly, blocking rotations by avoiding muscular contractions of the traumatized limb, mobilization by trained paramedical teams, and ice during perioperative period; (3) routine prescription of 1 g of acetaminophen 3 times a day, and

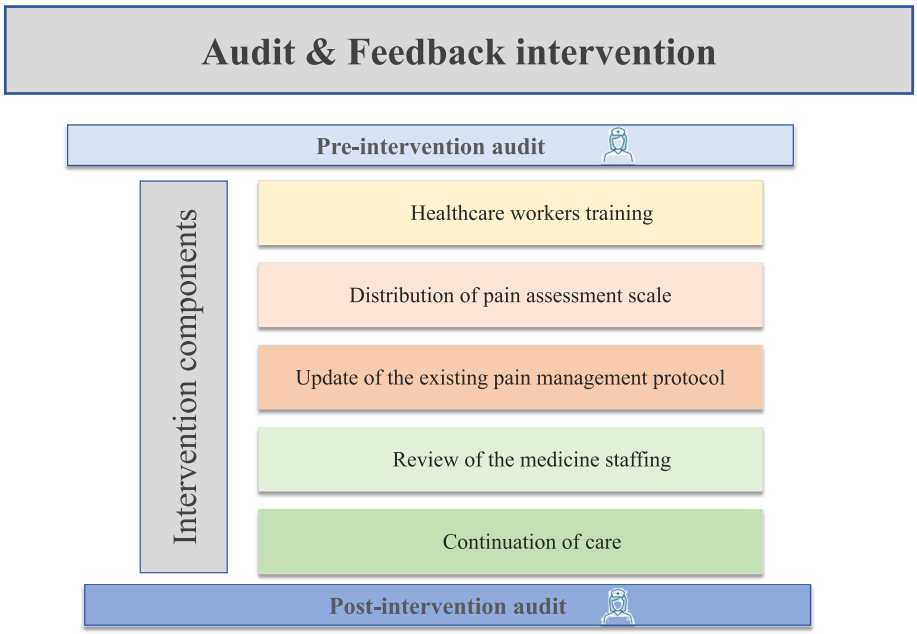

Fig. 2 Audit & Feedback intervention. A multimodal intervention including A&F was built with nurses. The A&F intervention which included a nurses' pre- and post-intervention audit was implemented in the orthogeriatric unit

5 mg per os of oxycodone (or equivalent) systematically distributed in the morning, before the nursing and the mobilization procedures; (4) conditional prescription of strong opioids based on pain intensity during all day. A pain intensity level greater than 6 induces opioid use. Data tracking of the numerical scale of prescriptions and analgesics given was performed by nursing staff. In the conventional orthopedic unit, no analgesic prescription protocol was used.

Participant patients

The study consecutively included 75 + hospitalized with hip fracture. The recruitment period lasted from December 2018 to April 2020. Patients were excluded in case of death before the surgery, admission after the surgery, multiple concomitant fractures, metastatic fractures, or functional management of the fracture. Patients who stayed less than 48 h in the unit or under any form of legal protection, or without collected data were also excluded from the study. Other reason such as acetaminophen allergy, early orthopedic complications (luxation within 48 h) could lead to study exclusion.

Data

The following data were collected during hospitalization in the medical report. The data were retrospectively gathered for the study from 01 January 2020 to 30 April 2021 by a clinical research associate: demographic characteristics (sex, age), fracture and surgery characteristics (type of fracture, type of surgery, type of anesthesia), preoperative delay (hours), medical history (comorbidities and treatments), standard geriatric measures such as scores to 6-point functional status according to the Katz's Activities of Daily Living scale (ADL) [25] and the 8-point Lawton's Instrumental Activities of Daily Living scale (IADL) [26], the 6-point American Society of Anesthesiologists score (ASA), the 56-point Cumulative Illness Rating Scale – Geriatric (CIRS-G) [27], the 24-point Charlson index score. Pain was assessed using 10-point VAS or numerical rating scale (NRS) [28]. All complications occurring during the hospital stay were collected including pain, delirium, anemia, bleeding, infection, fibrillation, stroke, myocardial infarction, thromboembolic event, stool impaction, urinary retention, pressure ulcer, dehydration, acute renal failure, and death. Functional status at discharge was assessed by ADL, and functional decline was calculated using the ADL score before the hip fracture (Day -15) and at discharge. For strong opioids, administered doses were calculated in mg/day of morphine equivalent using conversion factors [29]. For psychotropic drugs, distributed benzodiazepine (oxazepam) and hypnotic drugs were considered.

Statistics

Based on a pilot study, the primary endpoint (percentage of patients who received 3 g/day of acetaminophen each day during the perioperative period) was achieved in 30% of patients. To demonstrate a 20% improvement

in this proportion, with a risk of statistical error of 0.05 in a two-sided situation and a power of 0.90, a sample of 248 patients (124 patients in each group) was required.

Study data were collected through patient electronic records using Cristalnet and Easily software. Descriptive analysis was conducted on all collected variables, and on the total population collected. The primary analysis employed a difference-in-difference approach to investigate the first-order interaction between group (experimental versus control) and time (before versus after the A&F intervention) on the primary endpoint outcome (percentage of patients who received routine acetaminophen treatment). This was accomplished using a logistic regression model for independent binary variables. The crude interaction coefficient was then adjusted for baseline patient characteristics in a multivariate model to account for potential confounders. The baseline characteristics introduced in the model were selected by comparing the two groups at the two times of the study by association tests (Kruskal Wallis test for continuous variables or Chi^2 test for nominal variables). The same analysis looking for an interaction between group and time was performed for each of the secondary criteria. Odds ratios (ORs) were adjusted on age, sex, and type of fracture. Qualitative parameters were expressed in numbers and percentages. Quantitative parameters were described by the median with the 25th and 75th percentiles. Analysis was performed using data processed in Excel 2019 for PC, and statistics were performed with Stata Version 14.0 software (Stata Corporation, College Station, TX, USA). The significative level was set at 0.05.

Ethics

The study followed CNIL (National Commission on Informatics and Liberty, France) and RGPD (General Data Protection Regulation) recommendations. Study registration within the internal register for processing activities of the Data Protection Officer controller was performed prior to Clinical Research and Innovation Delegation approval (MR 4914030220). Our hospital ethics committee approved this study and authorized waived informed consent since the study was observational. Patients and their families were informed about the study and could refuse to participate.

Results

A total of 719 patients were screened to be included in this controlled before/after study. Of these, 397 were included: 99 before A&F intervention and 100 after A&F intervention in the experimental group, and 100 before A&F intervention and 98 after the A&F intervention in the control group (Fig. 3).

The median age of the included patients was 89 in the experimental group and 85 in the control group. Patients were mainly women (from 67 to 76% according to the group and the period). Patients in the experimental group were multimorbid and dependent. Patients frequently presented with femoral neck fracture. Detailed characteristics are presented in Table 1.

During the preoperative period, 9% of patients from the experimental group received 3 g/day of acetaminophen before the A&F intervention and 16% after the A&F intervention, without significant statistical difference ($p=0.13$) (Table 2).

During the postoperative period, 16% of patients from the experimental group received 3 g/day of acetaminophen before the A&F intervention; the percentage reached 60% after the A&F intervention (OR = 8.55 [4.29;17.03]; $p<0.001$). In the control group, no change in the distribution of acetaminophen was observed after the A&F intervention, neither in the preoperative ($p=0.76$) nor in the postoperative period ($p=0.43$). After the A&F intervention, the likelihood of receiving 3 g/day of acetaminophen during the postoperative period was significantly increased in the experimental group as compared with the control group (OR = 6.76 [2.7;16.9]; $p<0.001$). During the preoperative period, nurses' adherence to the medical prescriptions of acetaminophen was 13% in the experimental group before the A&F intervention and 32% after the A&F intervention ($p=0.001$). During the postoperative period, it was 13% in the experimental group before the A&F intervention, but reached 52% after the A&F intervention ($p<0.001$). The likelihood of adhering to medical prescription of acetaminophen was significantly increased in the experimental group as compared with the control group (OR = 20.34 [4.4;94.05], $p<0.001$). In the experimental group, the number of in-hospital VAS recorded slightly decreased after the A&F intervention ($p=0.02$). The strong opioid distribution during the pre and postoperative periods did not differ after the A&F intervention. In the preoperative period, the distribution of benzodiazepine significantly decreased after the A&F intervention ($p=0.007$); it was not significantly modified after the A&F intervention during the postoperative period ($p=0.33$).

The complication rates were not different before and after the A&F intervention (Table 3).

The functional status at discharge according to ADL score was better after the A&F intervention ($p=0.008$) in the experimental group, and the length of stay significantly decreased by 2.5 days ($p=0.002$).

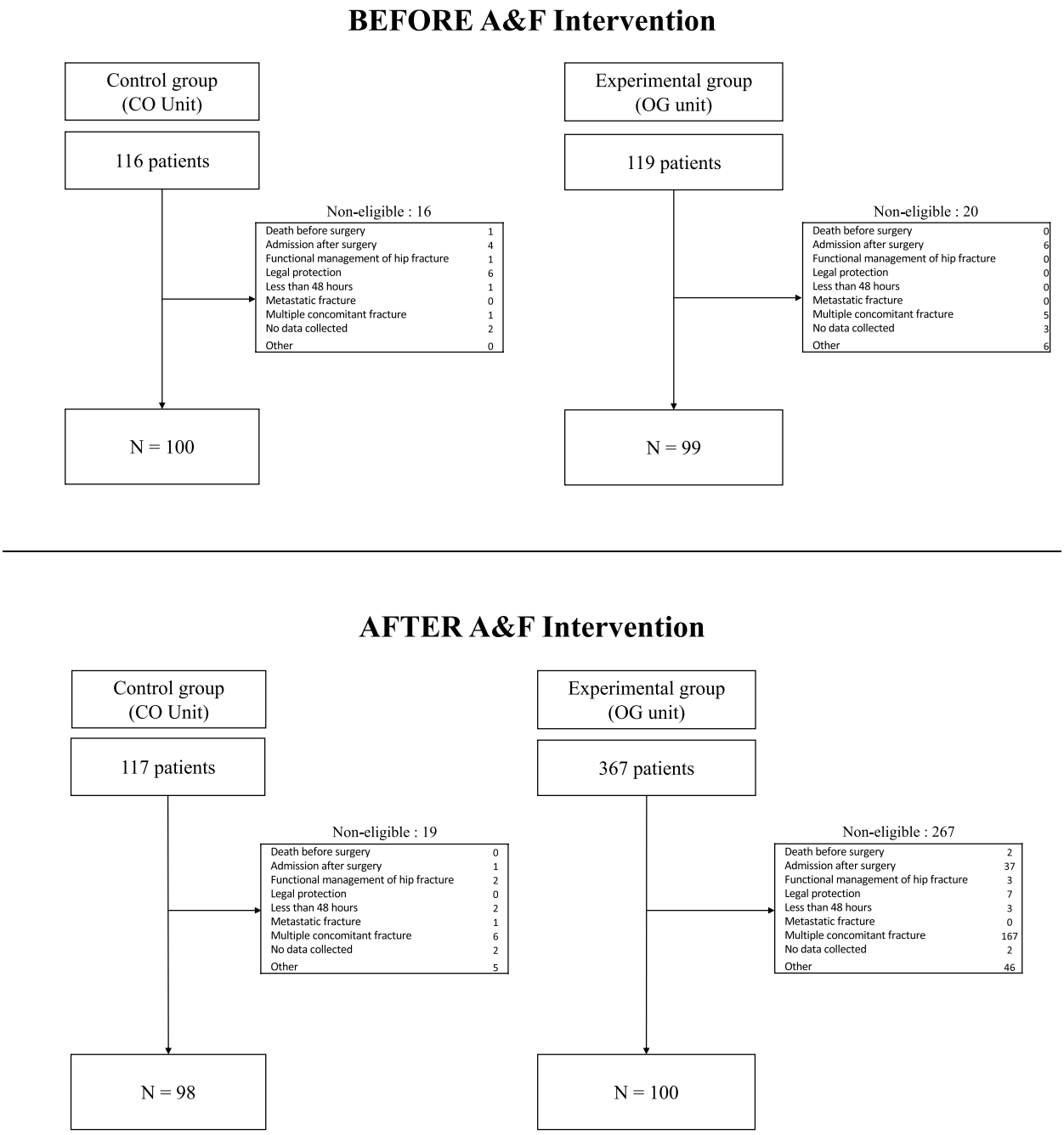

Fig. 3 Flowchart of the study. Abbreviations: OG: orthogeriatric unit; CO: conventional orthopedic unit

Discussion

Our controlled before/after study showed that an A&F intervention significantly improved perioperative pain management in older adults hospitalized for hip fracture. After the A&F intervention, the likelihood of receiving 3 g/day of acetaminophen during the postoperative period was significantly increased and the nurses' adherence to medical prescriptions based on acetaminophen prescription improved. In addition, the functional status at discharge according to ADL score was better after the A&F intervention and the length of stay in the orthogeriatric unit significantly shorter.

Our study presented several limitations. Firstly, the control group experienced a high rate of missing data due to conventional care without specific geriatric management and data collection. However, the missing data did

Table 1 Characteristics of the population

Characteristics		Experimental group (OG unit)					Control group (CO unit)				
		BEFORE (*n*=99)		AFTER (*n*=100)		*p*-value	BEFORE (*n*=100)		AFTER (*n*=98)		*p*-value
		N (%) or Median [IQR]		N (%) or Median [IQR]			N (%) or Median [IQR]		N (%) or Median [IQR]		
Age, median [IQR]		**89**	**[85-92]**	**89**	**[84-94]**	**0.90**	**85**	**[81-89]**	**85**	**[81-92]**	**0.95**
Women, n (%)		75	(75.0)	72	(72.0)	0.63	76	(76.0)	67	(68.4)	0.23
Fractures, n (%)											
-	Femoral neck fractures	52	(52.0)	51	(51.0)	0.89	40	(40.0)	47	(48.0)	0.26
-	Pertrochanteric fractures	43	(43.0)	41	(41.0)	0.77	52	(52.0)	46	(46.9)	0.48
-	Periprosthesic fractures	6	(6.0)	8	(8.0)	0.58	8	(8.0)	5	(5.1)	0.41
-	Fractures on screw	0	(0.0)	1	(1.0)	>0.99	0	(0.0)	0	(0.0)	ND
Surgery, n (%)											
-	Total prosthesis	12	(12.0)	15	(15.0)	0.86	44	(44.0)	53	(54.1)	0.10
-	Hemiarthroplasty	40	(40.0)	35	(35.0)		15	(15.0)	6	(6.1)	
-	Intramedullary nail	42	(42.0)	43	(43.0)		23	(23.0)	27	(27.6)	
-Other		6	(6.0)	7	(7.0)		18	(18.0)	12	(12.2)	
Anesthesia, n (%)											
-General[a]		60	(65.9)	51	(60.0)	0.42	33	(34.7)	42	(42.9)	0.25
-	Loco-regional[a]	42	(47.2)	39	(45.4)	0.81	69	(72.6)	59	(60.2)	0.07
Preoperative delay (h), median [IQR]											
-	Since emergency admission	78	[44-115]	47	[28-83]	<0.001	48.3	[27-74]	43.5	[24-67]	0.10
-	Since unit admission	52	[29-94]	35	[18-54]	<0.001	42	[22-66]	25.5	[20-48]	0.08
Comorbidity[a], median [IQR]											
-	CIRS-G	10	[8-12]	10	[8-12]	0.70	-		-		ND
-Charlson		3	[2-4]	3	[2-5]	0.16	-		-		ND
-	ASA	3	[2-3]	3	[3-3]	0.27	3	2-3	2	2-3	0.003
Usual medication, n (%)											
-	Acetaminophen	42	(42.0)	42	(42.0)	0.99	22	(22.0)	20	(20.6)	0.81
-	Low opioids	7	(7.0)	2	(2.0)	0.09	0	(0.0)	0	(0.0)	ND
-	Strong opioids	7	(7.0)	7	(7.0)	0.99	3	(3.0)	3	(3.1)	0.97
Functional status, median [IQR]											
-	ADL score (Day -15)[a]	4	[3-6]	5	[3-6]	0.13	-		-		ND
-	IADL score (Day -15)[a]	1	[0-5]	1	[0-6]	0.12	-		-		ND
-	ADL decline discharge minus Day -15)[a]	1.5	[1-2.5]	1.5	[0.5-2.5]	0.80	-		-		ND

Qualitative parameters were expressed in numbers and percentages. Quantitative parameters were described by the median with the 25th and 75th percentiles (IQR)

ADL Activities of Daily Living scale, *ASA* American Society of Anesthesiologists score, *CIRS-G* Cumulative Illness Rating Scale – Geriatric, *CO* conventional orthopedic unit, *IADL* Instrumental Activities of Daily Living scale, *IQR* Interquartile range, *ND* Not determined, *OG* Orthogeriatric unit

[a] In the experimental group, data were missing for 9 patients [BEFORE] and 15 patients [AFTER] for general anesthesia, 11 patients [BEFORE] and 14 patients [AFTER] for locoregional anesthesia, 31 patients [BEFORE] and 6 patients [AFTER] for the CIRS-G, 30 patients [BEFORE] and 7 patients [AFTER] for Charlson index score, 44 patients [BEFORE] and 9 patients [AFTER] for ASA, 6 patients [BEFORE] for ADL on Day -15, 9 patients [BEFORE] and 1 patient [AFTER] for IADL on Day -15. In the control group, data were missing for 5 patients [BEFORE] for general anesthesia, 5 patients [BEFORE] for locoregional anesthesia, 1 patient [AFTER] for acetaminophen, 79 patients [BEFORE] and 66 patients [AFTER] for ADL on Day -15, 82 patients [BEFORE] and 67 patients [AFTER] for IADL on Day -15. Moreover, CIRS-G and Charlson index score were not usually collected

not involve data of pain management (Table 2). Additionally, the perioperative complication rates did not decrease following the A&F intervention. However, it is important to note that the study was not designed to measure complication outcomes. A dedicated study should be conducted to assess the impact of the A&F intervention on complications. Finally, in contrast to other studies [30], we examined both prescription and medication distribution, thus considering the behaviors of both doctors and nurses.

In our study, acetaminophen distribution rate was extremely low and far from 100%. Several barriers to

Table 2 Impact of the intervention on clinical pain management

Pre or Post operative or in-hospital data	Experimental group (OG unit)						Control group (CO unit)						EXPERIMENTAL	
	BEFORE (n=99)		AFTER (n=100)		AFTER vs BEFORE		BEFORE (n=100)		AFTER (n=98)		AFTER vs BEFORE		vs CONTROL	
	n (%) or Median [IQR]		n (%) or Median [IQR]		OR or R [95%CI]	p-value	n (%) or Median [IQR]		n (%) or Median [IQR]		OR or R [95%CI]	p-value	OR or R [95%CI]	p-value
Acetaminophen: 3g/24h, n (%)														
Pre.	9	(9.0)	16	(16.0)	2.00 [0.83; 4.85]	0.13	6	(6.0)	5	(5.1)	0.82 [0.24; 2.83]	0.76	2.31 [0.5; 10.4]	0.28
Post.	16	(16.0)	60	(60.0)	8.55 [4.29; 17.03]	<0.001	29	(29.3)	33	(33.7)	1.28 [0.69; 2.39]	0.43	6.76 [2.7;16.9]	**<0.001**
Adherence to medical prescriptions[a], n (%)														
Pre.	13	(13.0)	32	(32.0)	3.28 [1.58; 6.81]	0.001	14	(14.0)	13	(13.3)	0.82 [0.36; 1.90]	0.65	3.39 [1.1; 0.04]	**0.03**
Post.	13	(13.1)	52	(52)	7.44 [3.65; 15.2]	<0.001	8	(8.1)	3	(3.1)	0.33 [0.08; 1.30]	0.11	20.34 [4.4; 94.05]	**<0.001**
VAS, median score [IQR]														
Pre.	1.14	[0.6; 2]	1.4	[0.7; 2.5]	0.04 [-0.01;0.1]	0.13	1.0	[0.7;1.7]	1.0	[0.7; 1.8]	0.04 [-0.07;0.14]	0.49	0.08 [-0.61; 0.77]	0.82
Post.	1	[0.6; 1.6]	1	[0.5; 1.5]	-0.03 [-0.12; 0.06]	0.57	1	[0.6 ; 1.6]	1.3	[0.9; 1.7]	0.09 [-0.02;0.20]	0.12	-0.25 [-0.57; 0.06]	0.12
In-hospital	0.9	[0.6; 1.5]	0.87	[0.6; 1.2]	-0.03 [-0.15;0.09]	0.60	1	[0.7 ; 1.4]	1.2	[0.9; 1.5]	0.13 [0.01; 0.26]	0.04	-0.22 [-0.46; 0.02]	0.07
Number of VAS performed, median [IQR]														
Pre.	7	[2.5; 14]	5	[2; 10.5]	-0.01 [-0.02;-0.0]	0.04	1	[0; 3]	1	[0; 4]	0.002 [-0.02;0.02]	0.82	-2.39 [-4.85 ;0.07]	0.057
Post.	13	[10; 15]	12	[10; 15]	-0.0001 [-0.02 ;0.01]	0.99	9	[3; 12]	6	[4; 13]	-0.002 [-0.02;0.01]	0.77	0.21 [-1.81; 2.23]	0.84
In-hospital	50	[39; 80]	47	[34.5; 69.5]	-0.003 [-0.005; -0.0]	0.02	27	[12; 40.5]	23.5	[12; 33]	-0.001 [-0.004; 0.002]	0.47	-7.45 [-17.9; 3.0]	0.16
Acetaminophen distributed: g/day, median [IQR]														
Pre.	1.95	[1.2; 2.4]	2.2	[1.6; 2.8]	0.11 [0.04;0.18]	0.004	1.2	[0.5;2]	1.3	[0.9; 2.2]	0.04 [-0.03; 0.11]	0.28	0.25 [-0.14; 0.63]	0.21
Post.	2.3	[1.7; 2.7]	3	[2.7; 3]	0.29 [0.20;0.38]	<0.001	2.3	[1.5; 3]	2.3	[1.5 ; 3]	0.02 [-0.05;0.10]	0.53	0.57 [0.25; 0.90]	**0.001**
Strong opioid distributed[b]: mg/day, median [IQR]														
Pre.	0	[0; 0]	0	[0; 0]	0.04 [-0.11; 0.19]	0.63	0	[0; 0]	0	[0; 0]	-0.01 [-0.05 ;0.03]	0.65	0.19 [-0.34; 0.71]	0.49
Post.	10	[5; 15]	10	[7.5; 17.5]	-0.001 [-0.01;0.01]	0.80	2.5	[0; 6.7]	2.5	[0; 6.7]	-0.003 [-0.01; 0.004]	0.42	0.43 [-4.08; 4.94]	0.85

Table 2 (continued)

Pre or Post operative or in-hospital data	Experimental group (OG unit)						Control group (CO unit)						EXPERIMENTAL	
	BEFORE (n=99)		AFTER (n=100)		AFTER vs BEFORE		BEFORE (n=100)		AFTER (n=98)		AFTER vs BEFORE		vs CONTROL	
	n (%) or Median [IQR]		n (%) or Median [IQR]		OR or R [95%CI]	p-value	n (%) or Median [IQR]		n (%) or Median [IQR]		OR or R [95%CI]	p-value	OR or R [95%CI]	p-value
Benzodiazepine distributed (mg), median [IQR]														
Pre.	0	[0 ; 10]	0	[0 ; 5]	-0.005 [-0.01; -0.001]	0.007	0	[0 ; 0]	0	0 [0 ; 0]	-0.001 [-0.01 ; 0.01]	0.81	-7.47 [-13.4; -1.57]	**0.01**
Post.	0	[0 ; 17.5]	0	[0 ; 10]	-0.003 [-0.008; 0.003]	0.33	0	[0 ; 0]	0	0 [0 ; 0]	0.001 [-0.01;0.01]	0.88	-2.17 [-6.74; 2.40]	0.35
Hypnotic drug distributed (mg), median [IQR]														
Pre.	0	[0 ; 0]	0	[0 ; 0]	-0.03 [-0.06; 0.004]	0.09	0	[0 ; 0]	0	[0 ; 0]	-0.02 [-0.04 ; 0.004]	0.10	0.18 [-0.80; 1.17]	0.72
Post.	0	[0 ; 0]	0	[0 ; 0]	-0.05 [-0.1; -0.01]	0.03	0	[0 ; 0]	0	[0 ; 0]	-0.004 [-0.02 ; 0.01]	0.63	-0.20 [-1.34; 0.95]	0.74

CO Conventional orthopedic unit, *IQR* Interquartile, *OG* Orthogeriatric unit, *OR* Odds ratio, *Pre* Preoperative, *Post* Postoperative, *R* Regression coefficient, *VAS* Visual analog scale

[a] assessed through acetaminophen

[b] in morphine sulfate equivalent

Qualitative parameters were expressed in numbers and percentages. Quantitative parameters were described by the mean ± standard deviation, and by median with the 25th and 75th percentiles

Table 3 Impact of the intervention on the patient outcomes

	Experimental group (OG unit)				Control group (CO unit)				EXPERIMENTAL	
	BEFORE ($n=99$)	AFTER ($n=100$)	AFTER vs BEFORE		BEFORE ($n=100$)	AFTER ($n=98$)	AFTER vs BEFORE		vs CONTROL	
	n (%) or Median [IQR]	n (%) or Median [IQR]	OR or R [95%CI]	*p*-value	n (%) or Median [IQR]	n (%) or Median [IQR]	OR or R [95%CI]	*p*-value	OR or R [95%CI]	*p*-value
Complications, n (%)										
Delirium	25 (25.3)	24 (24.0)	0.93 [0.48; 1.78]	0.82	3 (3.0)	0 (0.0)	ND	-	ND	-
Pneumonia	16 (16.2)	8 (8.0)	0.43 [0.17; 1.06]	0.07	1 (1.0)	2 (2.0)	2.02 [0.18; 23.2]	0.57	0.22 [0.02; 2.86]	0.25
Other infections	27 (27.3)	19 (19.0)	0.63 [0.32; 1.23]	0.17	0 (0.0)	1 (1.0)	ND	-	ND	-
Urinary retention	19 (19.2)	18 (18.0)	0.90 [0.44; 1.85]	0.77	3 (3.0)	4 (4.1)	1.27 [0.27; 5.99]	0.76	0.69 [0.13; 3.73]	0.67
Stool impaction	9 (9.1)	9 (9.0)	1.01 [0.38; 2.69]	0.98	0 (0.0)	1 (1.0)	ND	-	ND	-
Pressure ulcer	18 (18.2)	15 (15.0)	0.77 [0.36; 1.65]	0.51	8 (8.0)	4 (4.1)	0.48 [0.14; 1.68]	0.25	1.68 [0.39; 7.16]	0.48
Venous thromboembolism	13 (13.1)	18 (18.0)	1.47 [0.68; 3.21]	0.33	0 (0.0)	2 (2.0)	ND	-	ND	
Atrial fibrillation	8 (8.1)	5 (5.0)	0.60 [0.19; 1.93]	0.40	0 (0.0)	3 (3.1)	ND	-	ND	
Acute coronary disease	1 (1.0)	1 (1.0)	1.00 [0.06; 16.39]	0.99	0 (0.0)	1 (1.0)	ND	-	ND	
Heart failure	20(20.2)	26 (26.0)	1.39 [0.70; 2.73]	0.35	0 (0.0)	2 (2.0)	ND	-	ND	
Stroke	3(3.0)	0 (0.0)	ND	-	0 (0.0)	0 (0.0)	ND	-	ND	
Acute renal failure	3 (3.0)	9 (9.0)	3.12 [0.82; 11.94]	0.10	5 (5.0)	2 (2.0)	0.41 [0.08; 2.19]	0.30	7.95 [0.94;67.4]	0.06
Hemorrhage	16 (16.2)	16 (16.0)	0.98 [0.46; 2.10]	0.97	0 (0.0)	0 (0.0)	ND	-	ND	-
Death (Day 30)	5 (5.0)	2 (2.0)	0.34 [0.06; 1.87]	0.22	1 (1.0)	0 (0.0)	ND	-	ND	-
Other outcomes, median [IQR]										
ADL at discharge[a]	2 [1; 3]	2.5 [1.5; 4]	0.08 [0.02; 0.13]	0.008	2.5 [1.5;4.5]	4 [2.5; 4]	0.05 [-0.06; 0.15]	0.36	0.19 [-0.75; 1.12]	0.70
Length of hospital stay (days)	16 [12.5; 20]	13 [10; 16]	-0.02 [-0.03; -0.01]	0.001	12 [9.5;16]	10 [8; 14]	-0.02 [-0.03; -0.004]	0.01	-1.04 [-3.30; 1.21]	0.36

Table 3 (continued)

	Experimental group (OG unit)				Control group (CO unit)				EXPERIMENTAL	
	BEFORE ($n=99$)	AFTER ($n=100$)	AFTER vs BEFORE		BEFORE ($n=100$)	AFTER ($n=98$)	AFTER vs BEFORE		vs CONTROL	
	n (%) or Median [IQR]	n (%) or Median [IQR]	OR or R [95%CI]	*p*-value	n (%) or Median [IQR]	n (%) or Median [IQR]	OR or R [95%CI]	*p*-value	OR or R [95%CI]	*p*-value
Length of unit stay (days)	15 [12; 19]	12.5 [10; 16]	-0.02 [-0.03; -0.01]	0.002	12 [9;16]	10 [8;14]	-0.02 [-0.03; -0.003]	0.02	-0.71 [-2.81;1.40]	0.51

Qualitative parameters were expressed in numbers and percentages. Quantitative parameters were described using median and the 25th and 75th percentiles

ADL Activities of Daily Living scale, *CO* Conventional orthopedic unit, *IQR* Interquartile, *ND* Not determined, *OG* Orthogeriatric unit, *OR* Odds ratio, *Pre* Preoperative, *Post* Postoperative, *R* Regression coefficient, *VAS* Visual analog scale

[a] In the experimental group, data were missing for 30 patients [BEFORE] and 8 patients [AFTER] for ADL score at discharge; these data were missing for 87 patients [BEFORE] and 68 patients [AFTER] discharge in the control group

optimal pain control have been described with four distinct areas: healthcare system; physicians; nurses; patients [20, 31, 32]. Pain undertreatment usually affects the old-old and those with cognitive impairment [33]. Our study assessed the management of an acute and foreseeable pain, in an established traumatic context, in older adults, with routine medical prescription leaving no room for interpretation. The major finding was the gap between analgesic prescription and drug distribution with a real lack of adherence to medical prescriptions. Acetaminophen was usually prescribed and nurse's adherence to medical prescription was low. This gap has been known for a long time in the postoperative period in such context. Two thirds of patients received less than 50% of the prescribed non-opioid analgesic [33] and the administration of combination of drugs (i.e., acetaminophen with opioids) is low [34]. Strong opioids distribution in patients aged over 65 years and hospitalized for a hip fracture is lower than the dose prescribed [33]. Nurses are responsible for treatment distribution and administration; their poor knowledge leads to their non-adherence to good clinical practices [20]. Comprehensive knowledge encompasses both pain assessment and pain management [32].

Pain assessment and management could be improved by improving nurse's knowledge and attitudes [32, 35, 36]. Education programs may exert a positive impact on nurses' attitude toward pain management [37, 38]. Our study directly measured the effect of our multimodal intervention on nurses' attitudes and practices. The distribution of pain medication was greatly increased in the postoperative period thanks to our A&F intervention. Strong opioid distribution did not decrease following the A&F intervention, but our study did not aim to compare optimal pain management with non-optimal pain management. Furthermore, this could be a sign of the good quality of care in the unit. In a recent study [39], we demonstrated that 75 + with or without cognitive deficits or delirium hospitalized for a hip fracture in an orthogeriatric unit received the same daily average quantity of strong opioids during the preoperative period. The standard pain management in an orthogeriatric unit avoids the undertreatment of pain in patients with moderate to strong cognitive deficits.

Functional status at discharge was better. The A&F intervention improved pain management and thus enhanced patients' mobility during hospital stay. The functional recovery was facilitated and we could link the pain management to clinical usefulness of patients. The length of stay (LOS) decreased in the two groups. A better functional status may be associated with a reduction of LOS but external factors may have influenced this data (availability of rehabilitation center…).

Despite the A&F intervention, the rate of nurses' adherence to medical prescriptions remained insufficient. Dihle reported that nurses did not always use their knowledge in clinical practice, which led to a huge gap between "what nurses say and what nurses do" [34]. This constitutes a barrier to an optimal postoperative pain management. Educational interventions succeed in improving knowledge and practices but their impact on health provider's beliefs is controversial [35]. Subconscious barriers have been described [40], leading to a gap "between the nurses' own perceptions about how they dealt with postoperative pain management and how they actually performed it in the clinical setting" [34]. Secondly, the A&F intervention failed in the preoperative period.

Conclusions

By demonstrating that less than one quarter of patients received the optimal dosage of acetaminophen despite routine medical prescription, this study is an opportunity to question ourselves about our practices from prescription to administration including medication circuit, and to raise awareness of healthcare providers about this alarming issue. The management of pain is still not up to the mark. Defining clinical practice guidelines or pain action plan is not sufficient. In contrast to the opioid crisis, our challenge is not excessive use, but rather the underuse of a front-line medication named acetaminophen. It might be referred to as an "acetaminophen crisis". Our A&F intervention could potentially be used by other healthcare team managers to develop practice assessment in their own unit and pain education program. Team involvement in continuous education seems to be a key determinant of pain management quality and more studies are needed to assess factors associated with an optimal pain management in traumatized older adults.

Abbreviation

A&F Audit and Feedback

Acknowledgements

We thank the University Hospital Grenoble Alpes for the funding. We thank Fabienne Peretz for editorial assistance.

Authors' contributions

SD: Conceptualization (C), Funding Acquisition (FA), Project Administration (PA), Methodology (M), Supervision (S), Investigation (I), Formal analysis (Fa), Validation (Va) Visualization (V), Writing original Draft, Writing – Review-Editing (WRE); BB (M, Fa, Software (S), Data curation (DC), Va, M,V, WRE); AG (M, DC, S,V); AB (I, WRE) FO (I,V); MR (I, M,V); LM (I,V); AG (I, Fa,V); CM (M,V); RP (I, V); BRD (I, V); PB (C, I, V); JT (C, I, V); CB (I, V, R); GG (C, M, ID, M, V, WRE); PF (M, M, V); PG (M, I, M, V, WRE).

Funding

The University Hospital Grenoble Alpes funded the study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study followed CNIL (National Commission on Informatics and Liberty, France) and RGPD (General Data Protection Regulation) recommendations. Study registration within the internal register for processing activities of the Data Protection Officer controller was performed prior to Clinical Research and Innovation Delegation approval (MR 4914030220). Our hospital ethics committee approved this study and authorized waived informed consent since the study was observational. Patients and their families were informed about the study and could refuse to participate.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Univ. Grenoble Alpes, University Hospital Grenoble Alpes, Orthogeriatric Unit, Orthopaedic and Traumatology Surgery Department , Grenoble, France. [2]Univ. Grenoble Alpes, University Hospital Grenoble Alpes, Geriatric Department, Grenoble, France. [3]Univ. Grenoble Alpes, University Hospital Grenoble Alpes, Clinical Epidemiology and Medical Evaluation - Quality of Care Unit, Grenoble, France. [4]Univ. Grenoble Alpes, University Hospital Grenoble Alpes, Pharmacy Department, Grenoble, France. [5]Univ. Grenoble Alpes, University Hospital Grenoble Alpes, Public Health Department, Grenoble, France. [6]Univ. Grenoble Alpes, University Hospital Grenoble Alpes, Anesthesiology Department, Grenoble, France. [7]Center for Pain Treatment, University Hospital Grenoble Alpes, Grenoble, France. [8]Univ. Grenoble Alpes, University Hospital Grenoble Alpes Southern Site, Orthopaedic and Traumatology Surgery Department, Grenoble, France. [9]Univ. Grenoble Alpes, Grenoble Institut Neurosciences, Inserm, Grenoble U1216, France.

Received: 22 February 2024 Accepted: 5 August 2024
Published online: 05 September 2024

References

1. Sanzone AG. Current challenges in pain management in hip fracture patients. J Orthop Trauma. 2016;30(Suppl 1):S1-5.
2. Mosk CA, Mus M, Vroemen JP, van der Ploeg T, Vos DI, Elmans LH, et al. Dementia and delirium, the outcomes in elderly hip fracture patients. Clin Interv Aging. 2017;12:421–30.
3. Morrison RS, Magaziner J, McLaughlin MA, Orosz G, Silberzweig SB, Koval KJ, et al. The impact of post-operative pain on outcomes following hip fracture. Pain. 2003;103(3):303–11.
4. Chou R, Gordon DB, de Leon-Casasola OA, Rosenberg JM, Bickler S, Brennan T, et al. Management of postoperative pain: a clinical practice guideline from the american pain society, the American society of regional anesthesia and pain medicine, and the American society of anesthesiologists' committee on regional anesthesia, executive committee, and administrative council. J Pain. 2016;17(2):131–57.
5. Jones J, Southerland W, Catalani B. The importance of optimizing acute pain in the orthopedic trauma Patient. Orthop Clin North Am. 2017;48(4):445–65.
6. Aubrun F, Baillard C, Beuscart JB, Billard V, Boddaert J, Boulanger É, et al. Recommandation sur l'anesthésie du sujet âgé : l'exemple de fracture de l'extrémité supérieure du fémur. Anesthésie Réanim. 2019;5(2):122–38 Available from: https://linkinghub.elsevier.com/retrieve/pii/S2352580018302016. Cited 2021 Sep 9.
7. Remy C, Marret E, Bonnet F. Effects of acetaminophen on morphine side-effects and consumption after major surgery: meta-analysis of randomized controlled trials. Br J Anaesth. 2005;94(4):505–13.
8. Garlich JM, Pujari A, Moak Z, Debbi E, Yalamanchili R, Stephenson S, et al. Pain management with early regional anesthesia in geriatric hip fracture patients. J Am Geriatr Soc. 2020;68(9):2043–50.
9. Ftouh S, Morga A, Swift C, Guideline Development Group. Management of hip fracture in adults: summary of NICE guidance. BMJ. 2011;342.
10. American Society of Anesthesiologists Task Force on Acute Pain Management. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of anesthesiologists task force on acute pain management. Anesthesiology. 2012;116(2):248–73.
11. Girard P, Sourdet S, Cantet C, de Souto BP, Rolland Y. Acetaminophen safety: risk of mortality and cardiovascular events in nursing home residents, a prospective study. J Am Geriatr Soc. 2019;67(6):1240–7.
12. Macario A, Royal MA. A literature review of randomized clinical trials of intravenous acetaminophen (paracetamol) for acute postoperative pain. Pain Pract. 2011;11(3):290–6.
13. Gaskell H, Derry S, Moore RA, McQuay HJ. Single dose oral oxycodone and oxycodone plus paracetamol (acetaminophen) for acute postoperative pain in adults. Cochrane Database of Systematic Rev. 2009;(3):CD002763. https://doi.org/10.1002/14651858.CD002763.pub2.
14. Griffiths R, Alper J, Beckingsale A, Goldhill D, Heyburn G, et al. Management of proximal femoral fractures 2011: Association of Anaesthetists of Great Britain and Ireland. Anaesthesia. 2012;67(1):85–98.
15. Haines KL, Fuller M, Antonescu I, Vaughan JG, Raghunathan K, Cox CE, et al. Underutilization of Acetaminophen in Older Adult Trauma Patients. Am Surg. 2022;88(8):2003–10.
16. Knopp-Sihota JA, Patel P, Estabrooks CA. Interventions for the treatment of pain in nursing home residents: a systematic review and meta-analysis. J Am Med Dir Assoc. 2016;17(12):1163.e19-1163.e28.
17. Holloway H, Parker D, McCutcheon H. The complexity of pain in aged care. Contemp Nurse. 2018;54(2):121–5.
18. Shier V, Edelen MO, McMullen TL, Dunbar MS, Bruckenthal P, Ahluwalia SC, et al. Standardized assessment of cognitive function, mood, and pain among patients who are unable to communicate. J Am Geriatr Soc. 2022;70(4):1012–22.
19. Zhang CH, Hsu L, Zou BR, Li JF, Wang HY, Huang J. Effects of a pain education program on nurses' pain knowledge, attitudes and pain assessment practices in China. J Pain Symptom Manage. 2008;36(6):616–27.
20. Tomaszek L, Dębska G. Knowledge, compliance with good clinical practices and barriers to effective control of postoperative pain among nurses from hospitals with and without a "Hospital without Pain" certificate. J Clin Nurs. 2018;27(7–8):1641–52.
21. Tang Y, Zhang X, Yi S, Li D, Guo H, Liu Y, et al. Ultrasound-guided pericapsular nerve group (PENG) block for early analgesia in elderly patients with hip fractures: a single-center prospective randomized controlled study. BMC Anesthesiol. 2023;23(1):383.
22. Titler MG, Herr K, Schilling ML, Marsh JL, Xie XJ, Ardery G, et al. Acute pain treatment for older adults hospitalized with hip fracture: current nursing practices and perceived barriers. Appl Nurs Res. 2003;16(4):211–27.
23. Eid T, Bucknall T. Documenting and implementing evidence-based postoperative pain management in older patients with hip fractures. J Orthop Nurs. 2008;12(2):90–8. Available from: https://www.academia.edu/37081297/Documenting_and_implementing_evidence_based_post_operative_pain_management_in_older_patients_with_hip_fractures. Cited 2022 Feb 24
24. Ivers N, Jamtvedt G, Flottorp S, Young JM, Odgaard-Jensen J, French SD, et al. Audit and feedback: effects on professional practice and healthcare outcomes. Cochrane Database Syst Rev. 2012;14(6):CD000259.
25. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The index of adl: a standardized measure of biological and psychosocial function. JAMA. 1963;185:914–9.
26. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9(3):179–86.
27. Linn BS, Linn MW, Gurel L. Cumulative illness rating scale. J Am Geriatr Soc. 1968;16(5):622–6.
28. Herr K. Pain assessment strategies in older patients. J Pain. 2011;12(3 Suppl 1):S3-13.
29. Von Korff M, Korff MV, Saunders K, Thomas Ray G, Boudreau D, Campbell C, et al. De facto long-term opioid therapy for noncancer pain. Clin J Pain. 2008;24(6):521–7.
30. Bouri F, El Ansari W, Mahmoud S, Elhessy A, Al-Ansari A, Al-Dosari MAA. Orthopedic Professionals' Recognition and Knowledge of Pain and Perceived Barriers to Optimal Pain Management at Five Hospitals. Healthcare (Basel). 2018;6(3):98.
31. Coulling S. Nurses' and doctors' knowledge of pain after surgery. Nurs Stand. 2005;19(34):41–9.

32. Rababa M, Al-Sabbah S, Hayajneh AA. Nurses' perceived barriers to and facilitators of pain assessment and management in critical care patients: a systematic review. J Pain Res. 2021;14:3475–91.
33. Feldt KS, Ryden MB, Miles S. Treatment of pain in cognitively impaired compared with cognitively intact older patients with hip-fracture. J Am Geriatr Soc. 1998;46(9):1079–85.
34. Dihle A, Bjølseth G, Helseth S. The gap between saying and doing in postoperative pain management. J Clin Nurs. 2006;15(4):469–79.
35. Abdalrahim MS, Majali SA, Stomberg MW, Bergbom I. The effect of post-operative pain management program on improving nurses' knowledge and attitudes toward pain. Nurse Educ Pract. 2011;11(4):250–5.
36. Brunkert T, Simon M, Ruppen W, Zúñiga F. Pain management in nursing home residents: findings from a pilot effectiveness-implementation study. J Am Geriatr Soc. 2019;67(12):2574–80.
37. AlReshidi N, Long T, Darvill A. A systematic review of the impact of educational programs on factors that affect nurses' post-operative pain management for children. Compr Child Adolesc Nurs. 2018;41(1):9–24.
38. Casey SD, Stevenson DE, Mumma BE, Slee C, Wolinsky PR, Hirsch CH, et al. Emergency department pain management following implementation of a geriatric hip fracture program. West J Emerg Med. 2017;18(4):585–91.
39. Ruel M, Boussat B, Boudissa M, Garnier V, Bioteau C, Tonetti J, et al. Management of preoperative pain in elderly patients with moderate to severe cognitive deficits and hip fracture: a retrospective, monocentric study in an orthogeriatric unit. BMC Geriatr. 2021;21(1):575.
40. Schafheutle EI, Cantrill JA, Noyce PR. Why is pain management suboptimal on surgical wards? J Adv Nurs. 2001;33(6):728–37.

Publisher's Note