Acute Pain Resolution After an Emergency Department Visit: A 14-Day Trajectory Analysis

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Study objective: The objective of the study is to evaluate the acute pain intensity evolution in emergency department (ED) discharged patients, using group-based trajectory modeling. This method identifies patient groups with similar profiles of change over time without assuming the existence of a particular pattern or number of groups.

Methods: This was a prospective cohort study of ED patients aged 18 years or older, with an acute pain condition (≤2 weeks), and discharged with an opioid prescription. Patients completed a 14-day diary assessing daily pain intensity level (numeric rating scale of 0 to 10) and pain medication use.

Results: Among the 372 included patients, 6 distinct post-ED pain intensity trajectories were identified. Two started with severe levels of pain; one remained with severe pain intensity (12.6% of the sample) and the other ended with a moderate pain intensity level (26.3%). Two other trajectories had severe initial pain; one decreased to mild pain (21.7%) and the other to no pain (13.8%). Another trajectory had moderate initial pain that decreased to a mild level (15.9%) and the last one started with mild pain intensity and had no pain at the end of the 14-day period (9.7%). The pain trajectory patterns were significantly associated with age, type of painful conditions, pain intensity at ED discharge, and opioid consumption.

Conclusion: Acute pain resolution after an ED visit seems to progress through 6 different trajectory patterns that are more informative than simple linear models and could be useful to adapt acute pain management in future research. [Ann Emerg Med. 2019;74:224-232.]

Please see page 225 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Pain is one of the major complaints in the emergency department (ED) visit, and 74% of patients who present with at least moderate pain are discharged with moderate to severe pain.[1] The management of acute pain after ED discharge remains a challenge, especially in the context of the opioid crisis.[2] Acute pain evolution may vary according to individual characteristics, the type of painful conditions (eg, fracture, sprain, renal colic), and pain medication treatment.[3] Therefore, it is important to evaluate the acute pain resolution process over time to determine whether individual patterns exist and eventually adapt pain management.

With the traditional growth curve modeling, short-term pain resolution after an ED visit for an acute pain condition or after a surgical procedure was described as a linear process.[4-8] These studies chose a linear model based on groups' average pain intensity evolution during 3 to 7 days and found 3 different general linear patterns according to positive, negative, or flat slope of pain evolution. However, it remained uncertain how well each patient trajectory fitted the linear model and whether the linear model was still applicable to data exceeding 7 days. Only one study, of hospitalized and surgical patients, showed that pain intensity levels displayed a nonlinear decrease during the first 48 hours after admission.[3]

Some patient characteristics and clinical outcomes were related to pain intensity evolution. The slope or intercept of pain intensity's linear fit was associated with sex,[4,5] injury location,[5] surgical sites,[4] and age[4] in the ED or surgery population. Pain trajectory clusters were also associated with sex, age, ethnicity, and type of analgesic in hospitalized and surgical patients.[3] The development of chronic pain at 6 months was also associated with the intercept and slope of acute pain resolution after surgery.[8] However, another study in patients with lower extremity

Editor's Capsule Summary

What is already known on this topic

Pain resolution patterns after initial emergency department (ED) care can vary.

What question this study addressed

What does pain resolution look like after an ED visit that included an outpatient opioid prescription?

What this study adds to our knowledge

Using a 14-day patient diary for 372 patients from a single urban site, 6 distinct trajectories of recovery occurred, ranging from no to severe pain. Age, underlying condition, pain score at ED discharge, and opioid use were all associated with the patterns.

How this is relevant to clinical care

These observations reinforce that patients have variable pain patterns after an ED visit and inform future research.

injury showed that only the first pain score collected (and not the pain trajectory) was predictive of chronic pain.[7]

Growth curve modeling assumes that all subjects vary in the same way across time. Group-based trajectory modeling offers a more flexible approach in identifying subgroups of patients with similar patterns of change over time but without assuming the existence of a specific trend or number of groups.[9] With this analysis, pain evolution can be characterized by different kinds of trajectories: linear, quadratic (with 1 change in direction), cubic (with 2 changes in direction), etc. Assuming that every patient with acute pain does not follow the same path of pain resolution, group-based trajectory modeling should better capture these individual differences.

The main objective of this study was to characterize, using group-based trajectory modeling, the different pain trajectories of ED patients discharged with an opioid prescription. The secondary objective was to assess the relationship between acute pain trajectories and clinical outcomes. We hypothesized that patients would exhibit different trajectory patterns of acute pain resolution during a 14-day follow-up after ED discharge and that some of these would be nonlinear.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective cohort study conducted in the ED of a tertiary care Level I trauma center of an academic urban hospital with an affiliated emergency medicine residency program and an annual census of approximately 65,000 ED visits (mostly adults). This research was a planned analysis of a cohort created to evaluate acute pain management in patients who received an opioid prescription for acute pain after an ED visit.[10] Approval was obtained from the local institutional ethics review board.

Selection of Participants

Patients aged 18 years or older and treated in the ED from June 2016 to July 2017 were identified by emergency physicians continuously. We included patients with an acute pain condition present for less than 2 weeks who were discharged from the ED with an opioid prescription. All emergency physicians referred these patients to research nurses, who then verified inclusion and exclusion criteria, explained the study, and obtained informed consent. The selection of patients who received an opioid prescription was not predetermined; pain management was left to the treating physician's preference. This was a convenience sample because we were unable to reliably determine the number of patients missed by emergency physicians (no electronic tracking system for outpatient prescriptions). We excluded only patients who did not speak French or English, were using opioid medication before the ED visit (last 2 weeks), stayed in the ED for more than 48 hours, or had cancer or chronic pain.

Data Collection and Processing

Patients' demographic information, pain intensity at triage (11-point numeric rating scale), arrival mode, triage priority, and length of ED stay were extracted from our computerized medical system. Emergency physicians entered the final diagnosis, pain intensity at discharge (11-point numeric rating scale), and which pain medications were prescribed. Patients received a 14-day diary in which they recorded the quantity, time, and name of all the pain medication consumed daily. They were also asked to report their daily average pain level at the end of the day, using an 11-point numeric rating scale ranging from 0 to 10, in which 0 represented "no pain at all" and 10 represented "the worst imaginable pain." Unlike Chapman et al,[4,5] we did not include the pain at hospital discharge in the pain resolution trajectory analysis because we wanted to examine the pain intensity evolution at home, where pain management could be different from that in the ED. Patients used preaddressed and prestamped envelopes to mail the diaries back after their completion. We chose a 2-week follow-up period because it was a reasonable acute-pain time frame definition,[11] and it was also during this period that the pain medication need was significantly resolved for a majority of patients (88%) in our pilot

study.[12] A research assistant also contacted patients by telephone 1 week later to evaluate whether they were filling out the diary, to answer any of their questions about its usage, and to remind them of the importance of mailing it back to us 2 weeks after the initial ED visit. Study data were entered and managed with Research Electronic Data Capture (version 6.16.6; Vanderbilt University, Nashville, TN), a secure, Web-based application tool hosted in the hospital.[13]

The quantity of opioid pills prescribed and consumed could not be analyzed directly because of the particular potency and dosage of each opioid. To compare the different opioid forms, each opioid was transformed into an oral morphine 5-mg pill equivalent,[14] using the Berdine and Nesbit[15] method. A dosage of 3.33 mg of oxycodone and 1.25 mg of hydromorphone was considered equipotent to one 5-mg morphine pill. For example, 5 mg of oxycodone and 2 mg of hydromorphone would be equivalent to 7.5 mg and 8 mg of morphine, respectively. Nonsteroidal anti-inflammatory drugs were also converted to a 1,000-mg naproxen pill equivalent according to the method of Dougados et al.[16] A dose of 1,000 mg of naproxen was considered equivalent to 2,400 mg of ibuprofen, 150 mg of indometacin, and 400 mg of celecoxib. Finally, acetaminophen was converted to a 500-mg pill equivalent (no combinations with opioids were used).

Primary Data Analysis

Group-based trajectory modeling[17] is a statistical tool that identifies groups of patients with similar behavior evolution over time—in the present case, pain intensity resolution during a 14-day period—without assuming the existence of a specific trend or number of groups. However, this method requires at least 100 participants (ideally more than 300) and a minimum of 3 time points.[18] When data are missing at random, maximum likelihood estimations will provide parameters that are asymptotically unbiased. Thus, missing data patterns have to be explored to guarantee unbiased parameters.[19] In addition, as sensitivity analysis, we also performed trajectory analysis with a complete data set, using multiple imputations with 5 different pattern estimations. The multiple imputation analysis was conducted with the 14 daily pain intensity ratings of all patients, using the fully conditional specification method with 100 iterations and value constraints between 0 and 10 for each variable.

The first group-based trajectory modeling step was to determine the number of trajectories that best fit the data. To help determine the best model, the Bayesian information criteria are commonly used. These criteria measure adequacy of the model by penalizing its estimates by the complexity of the model. Highest Bayesian information criteria values are preferred, but to evaluate meaningful changes in Bayesian information criteria, the Bayes factor ($\exp^{(\text{Bayesian information criteria 1}-\text{Bayesian information criteria 2})}$) was proposed.[20] To select the number of trajectories to include in the final model, the Bayesian information criteria change magnitude between models must represent a 10-fold difference from the Bayes factor, and the estimated percentage of patients in each trajectory must be at least 5%.[20] The second group-based trajectory modeling step was to characterize the shapes of each trajectory by fitting it to a linear, quadratic, or cubic polynomial pain evolution pattern. Again, the Bayesian information criteria change and having at least 5% of patients in each trajectory guided the model selection process.

Group-based trajectory modeling also assigned each subject a posterior probability (maximum probability rule) of belonging to a specific trajectory, given its pain intensity level across the 14-day period. This probability was used to assess the general fit of the model, using 3 criteria: an average posterior probability of at least 70% for each trajectory; an odds of correct classification of 5 or more for all trajectories, which evaluates whether the maximum probability rule is better than guessing; and the differences between the estimated group membership probabilities and the actual proportion assigned to a group, using the maximum probability rule, that should be close to zero.[19] To name each trajectory according to the initial and final pain intensity level after ED discharge, we categorized pain intensity measured with numeric rating scale as no pain (0), mild (1 to 4), moderate (5 to 6), and severe (7 to 10).[21] PROC TRAJ, a procedure from SAS Institute, Inc. (version 6.3; SAS, Cary, NC), containing the maximum likelihood method was used to estimate parameters, group sizes and shapes of pain intensity evolution, and to perform trajectory analysis.

To evaluate whether the acute pain resolution in our ED population was similar to that observed in the literature, we compared our group average pain intensity during the first 6 days after ED discharge with results obtained by Chapman et al[5] by fitting a linear ($y=Ax+B$) function, using the least square regression method.

Baseline characteristics of patients included in the study, those who refused to participate, and those who did not return the diary are presented with descriptive statistics. We calculated differences in median and in proportion with associated 95% confidence intervals (CIs) for included patients compared with the other 2 groups. Hodges-Lehman estimates were used to calculate 95% CIs of median differences. Patient clinical characteristics (age, sex,

pain conditions, pain intensity at discharge, and pain medication consumed) were compared across pain trajectories, using median or percentage with their 95% CIs. We grouped pain conditions into 4 categories frequently reported in the ED[22]: musculoskeletal, fracture, renal colic, and other pain complaints (eg, abdominal pain, abscess, burn, tooth pain). α Level was set at .05, and analyses were performed with SPSS (version 23; IBM, Somers, NY).

RESULTS

Characteristics of Study Subjects

During our 1-year recruitment period, a total of 1,315 patients meeting the inclusion criteria were initially contacted. Of these patients, almost one third had exclusion criteria, 13% declined to participate, slightly more than half of the included patients returned the diary, and 1% had fewer than 3 valid data points for the 14-day follow-up, leaving 372 participants (Figure 1). Nonparticipating and included patients were similar in regard to baseline characteristics, except for age and nonsteroidal anti-inflammatory drug prescriptions at ED discharge (Table 1). Patients lost to follow-up were significantly younger and received more nonsteroidal anti-inflammatory drug prescriptions at ED discharge than included patients. Included patients' median age was 54 years, half were women, and pain intensity at triage was severe, decreasing to moderate at ED discharge. The median number of 5-mg morphine pills prescribed at ED discharge was 30. During the 14-day follow-up, 82% of patients consumed opioids, 72% consumed acetaminophen, and 45% consumed nonsteroidal anti-inflammatory drugs. When we compared our data with those of Chapman et al,[5] we observed that our ED population produced a similar linear fit on the first 6 days of pain intensity, with a slope of –0.48 (95% CI –0.62 to –0.33) and an intercept of 6.7 (95% CI 6.2 to 7.4).

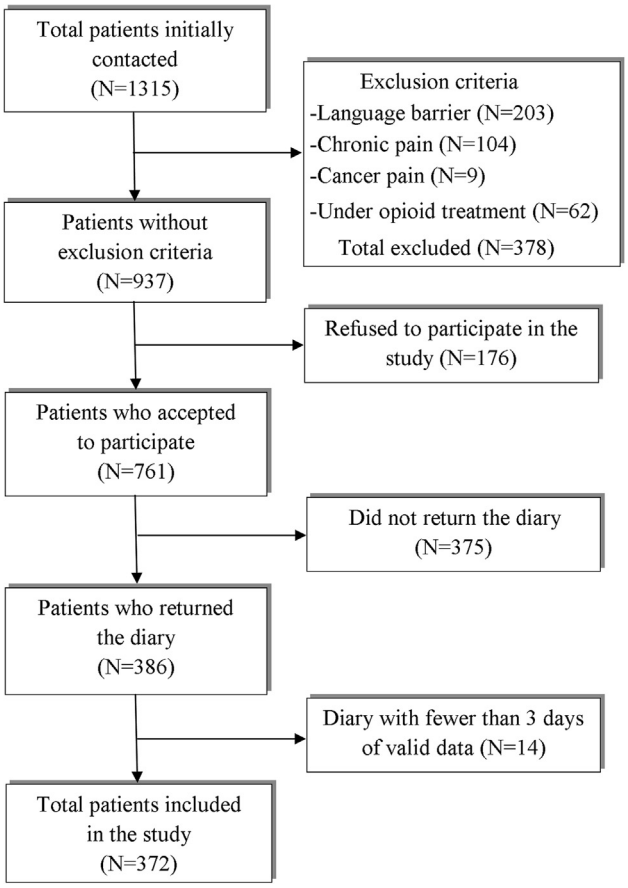

Figure 1. Flowchart of patients' enrollment in the study.

The percentage of days with missing pain intensity data during the follow-up was 13% for the whole sample and tended to increase at the end of the 14-day period. However, 64% of patients had all 14 days of pain intensity data. Baseline characteristics of patients with a complete data set were not significantly different from those with at least one missing data point. Using the method adopted by Niyonkuru et al,[19] we investigated whether the pattern of missing data in our sample was related to the trajectory results by creating 2 dummy variables: missing data late in the follow-up period (days 12 to 14 with missing data), and less than 7 days of valid data (higher missing data rate). Twenty percent of subjects had missing data for days 12 to 14 and 11% of patients had fewer than 7 data points. There were no associations between these 2 variables and the trajectory groups (all $P>.45$), suggesting that the data missing at random assumption were not violated.

Main Results

According to Bayesian information criteria changes, the model with 7 trajectories best fitted the data, but the percentage of patients estimated in the smallest group was less than 5%. Therefore, the model with 6 trajectories, 2 linear and 4 cubic polynomial order patterns, was retained (Table E1 [available online at http://www.annemergmed.com], Figure 2). The 2 linear groups started with severe levels of post-ED pain; one remained with severe pain intensity at the end of the 14-day period (severe to severe, 12.6% of the sample; 95% CI 8.8% to 16.5%) and the other ended with a moderate pain intensity level (severe to moderate, 26.3%; 95% CI 21.3% to 31.3%). Two other trajectory groups had a severe initial pain intensity level; one decreased to a final mild pain level (severe to mild) (21.7%; 95% CI 16.7% to 26.8%) and the other to a final no-pain condition (severe to no pain) (13.8%; 95% CI 10.0% to 17.5%). Another group had

Table 1. Baseline characteristics of patients included in the study, those who refused to participate, and those who did not return the diary or had less than 3 days of valid data (lost to follow-up).

Baseline Characteristics	Included (N=372)	Refused to Participate (N=176)	Lost to Follow-up (N=389)	Difference (95% CI), Included vs Refused	Difference (95% CI), Included vs Lost
Age, median (IQR, range), y	54 (43 to 66, 18 to 95)	53 (39 to 66, 18 to 91)	44 (35 to 56, 18 to 92)	1 (−2 to 5)	10 (7 to 12)
Sex, No. (%), men	185 (50)	82 (47)	218 (56)	3 (−6 to 12)	−6 (−13 to 1)
ED arrival mode, No. (%)					
By self	307 (83)	134 (76)	299 (77)	7 (0 to 14)	6 (0 to 12)
By ambulance	65 (17)	42 (24)	89 (23)		
High (level 1 or 2) triage priority, No. (%)	155 (42)	79 (45)	173 (45)	−3 (−12 to 6)	−3 (−10 to 4)
Pain intensity at triage, median (IQR)	8 (7 to 9)	8 (7 to 10)	8 (7 to 10)	0 (0 to 0)	0 (0 to 0)
ED treatment section, No. (%)					
Ambulatory	250 (67)	110 (63)	243 (63)	4 (−5 to 13)	4 (−3 to 11)
On stretcher	122 (33)	66 (37)	145 (37)		
Type of pain conditions, No. (%)					
Musculoskeletal	164 (45)	72 (41)	161 (41)	4 (−5 to 13)	4 (−3 to 11)
Fracture	68 (19)	41 (23)	70 (18)	−4 (−11 to 2)	1 (−5 to 7)
Renal colic	60 (17)	33 (19)	67 (17)	−2 (−9 to 5)	0 (−5 to 5)
Other	71 (20)	30 (17)	91 (23)	3 (−4 to 10)	−3 (−9 to 3)
Acetaminophen* prescriptions at ED discharge, No. (%)	264 (71)	122 (69)	281 (72)	2 (−6 to 10)	−1 (−7 to 5)
NSAID prescriptions at ED discharge, No. (%)	154 (41)	75 (43)	205 (53)	−2 (−11 to 7)	−12 (−19 to −5)
Opioid prescription types at ED discharge, No. (%)					
Morphine	158 (42)	74 (42)	173 (45)	0 (−9 to 9)	−3 (−10 to 4)
Oxycodone	147 (40)	63 (36)	157 (40)	4 (−5 to 13)	0 (−7 to 7)
Hydromorphone	67 (18)	38 (22)	57 (15)	−4 (−11 to 3)	3 (−2 to 8)
No. of morphine 5-mg-equivalent pills prescribed, median (IQR)	30 (20 to 46)	30 (20 to 45)	30 (20 to 48)	0 (−1 to 3)	0 (−1 to 2)
ED stay duration, median (IQR), h	5 (4 to 7)	6 (4 to 8)	5 (4 to 8)	−1 (−1 to 0)	0 (−1 to 0)
Pain intensity at ED discharge, median (IQR)	5 (2 to 7)	5 (2 to 7)	5 (2 to 7)	0 (0 to 1)	0 (0 to 0)

IQR, Interquartile range; *NSAID*, nonsteroidal anti-inflammatory drug.
*Acetaminophen was always prescribed or verbally suggested separately from opioids (no combinations).

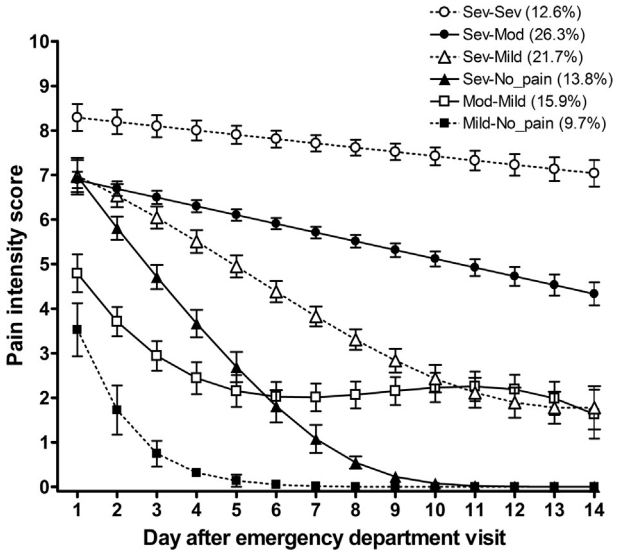

Figure 2. Group-based pain intensity trajectory representation of the final model with 6 pain trajectories. Each trajectory was named according to its initial and final pain intensity combination after ED discharge. Error bars represent 95% CIs. *Sev-Sev*, Severe initial pain intensity and severe final pain intensity; *Sev-Mod*, severe and moderate; *Sev-Mild*, severe and mild; *Sev-No_pain*, severe and no pain; *Mod-Mild*, moderate and mild; *Mild-No_pain*, mild and no pain.

moderate initial pain levels, which decreased to a mild level (moderate to mild) (15.9%; 95% CI 11.6% to 20.2%), and finally one group started with mild pain intensity and had no pain at the end of the 14-day follow-up (mild to no pain) (9.7%; 95% CI 6.6% to 12.8%). The evaluation of the fit of the 6-group model is presented in Table E2, available online at http://www.annemergmed.com. The average posterior probability of each group was higher than 90%, the odds of correct classification were all higher than 25, and the difference between the estimated group membership probabilities and the actual proportion assigned to a group using the maximum probability rule was close to zero, indicating an overall very good fit. Using multiple imputations as sensitivity analysis, we identified the same number of trajectories containing almost the same number of patients.

Acute pain trajectories differed significantly according to age; the severe to moderate group was older than the mild to no pain trajectory group (Table 2). Musculoskeletal pain was more often associated with severe to moderate and severe to mild trajectories than to any other trajectories, pain caused by fractures was generally associated with the severe to moderate trajectory, and renal colic pain was more often associated with the mild to no pain trajectory. As can be expected, patients with the severe to severe trajectory reported consuming more opioids than those with the severe to mild, severe to no pain, or moderate to mild trajectories, and in turn, patients in the latter trajectories consumed significantly more opioids than those in the mild to no pain trajectory.

Patients in the severe to no pain and mild to no pain trajectories reported consuming significantly less acetaminophen than those in the severe to mild, severe to moderate, or severe to severe trajectories. There was also an association between pain intensity at ED discharge and trajectory groups; mean pain intensity at discharge increased as the pain intensity trajectory severity increased. No significant effects of sex or nonsteroidal anti-inflammatory drug consumption were observed across the different pain trajectories.

LIMITATIONS

This study was conducted at a single site and carried out in an urban, academic, tertiary care hospital, and the findings may not generalize to other health settings. The low diary return rate obtained in the present study (51%) could also bias the representativeness of our sample. However, we did not find important differences between patients who completed the study and those who did not. The convenience sample limits the generalizability of our results because a selection bias could exist. Nevertheless, patients were recruited 24 hours a day, 7 days a week, and consecutive recruitment was limited only because the investigators could not determine the number of patients missed by emergency physicians (no electronic tracking system for outpatient prescriptions). Asking patients to average their daily pain intensity could also introduce measurement bias because pain probably fluctuates during the day, depending on activity and pain medication ingestion. The "other" pain condition was composed of different pain causes, and it is therefore possible that these pain conditions could generate different pain trajectories. Furthermore, self-reported opioid use could be biased by social desirability issues. Nonetheless, studies have shown self-reports of illicit substance use to be valid relative to urine drug screen.[23-25] Finally, we did not control for anxiety, depression, and pain catastrophizing, factors known to affect pain intensity evaluation.[26]

DISCUSSION

In agreement with our hypothesis, this prospective study showed that patients discharged with an opioid prescription followed different acute pain resolution patterns, some of them with linear trends and others with nonlinear evolution. Furthermore, these different acute pain trajectories were associated with clinical characteristics such as age, type of painful condition, pain intensity at ED discharge, and quantity of analgesics consumed during the follow-up.

Table 2. Comparison of patient's clinical characteristics between the 6 pain trajectory groups.

		Pain Trajectory				
Clinical Characteristics	**Mild/No Pain (N=36)**	**Mod/Mild (N=59)**	**Sev/No Pain (N=52)**	**Sev/Mild (N=77)**	**Sev/Mod (N=103)**	**Sev/Sev (N=45)**
Age, median (95% CI), y	47 (43–54)	57 (50–61)	50 (47–56)	53 (50–58)	56 (55–60)	56 (48–68)
Sex, % (95% CI), men	53 (36–70)	56 (42–69)	54 (40–68)	49 (38–61)	48 (38–58)	40 (26–56)
Type of pain conditions, % (95% CI)						
Musculoskeletal pain	3 (0–6)	13 (8–18)	15 (10–20)	26 (20–32)	30 (23–37)	14 (9–19)
Fracture	0 (–*)	12 (4–20)	1 (0–4)	26 (16–36)	41 (30–52)	20 (11–31)
Renal colic	38 (26–50)	15 (6–24)	20 (10–30)	10 (3–17)	13 (5–21)	5 (0–10)
Other	22 (8–36)	34 (22–46)	25 (13–37)	12 (5–19)	15 (8–22)	19 (11–27)
Pain intensity at ED discharge, median (95% CI)	1 (0–3)	3 (2–5)	5 (3–6)	5 (4–6)	6 (5–6)	7 (6–8)
Morphine 5-mg-equivalent pills consumed, median (95% CI)	0 (0–2)	6 (3–10)	5 (3–7)	8 (5–10)	12 (8–14)	21 (12–25)
Acetaminophen 500-mg-equivalent pills consumed, median (95% CI)	0 (0–2)	15 (2–32)	5 (2–12)	31 (26–39)	24 (15–30)	27 (15–52)
Naproxen 1,000-mg-equivalent pills consumed, median (95% CI)	0 (0–2)	0 (0–1)	2 (0–4)	1 (0–4)	0 (0–0)	0 (0–0)

Mod, Moderate pain intensity; *Sev*, severe pain intensity.
*Not applicable.

Using a linear fitting, with similar slope and intercept, we replicated the results of Chapman et al[5] during the first 6 days after ED discharge, suggesting that both populations are comparable in their average pain intensity evolution. Contrary to the growth curve modeling used by Chapman et al[4,5] and others,[6-8] which assumes that all patients' pain intensities vary linearly across time, the group-based trajectory modeling used in our study offered a more informative approach and revealed 6 acute pain trajectories. The averaging process of the linear fitting tended to mask individual differences in acute pain resolution that are influenced by factors such as individual characteristics (eg, age, sex, psychological factors, genetics), type of painful condition, initial pain intensity level, and type of pain treatment used.[3]

Two of the 6 trajectories were linear and similar to the pattern observed by Chapman et al,[5] one with almost no decrease in pain intensity and one with a slow decrease, but both still had at least moderate pain intensity at the 14-day follow-up. These 2 groups of patients with initial severe post-ED pain intensity and lower rate of pain resolution are probably at risk of developing chronic pain.[7,8] They tended to be older, which was similar to another study showing a slower rate of pain resolution with increasing age in postoperative conditions.[4] However, the same authors did not find any association of intercept or slope of pain trajectories with age in an ED population.[5] As expected, patients with higher initial and final pain intensities after ED discharge consumed more opioids than those in the other trajectories, similar to the study by Kannampallil et al.[3]

The 4 other pain intensity trajectories, representing 61% of the patients, were nonlinear in their evolution and had a mild pain intensity or no pain on day 14, which suggests that patients who experienced a more rapid decrease in pain intensity during the first days of the follow-up were those with better pain outcomes at the end of the 14 days. Contrary to the findings of Chapman et al,[5] who found that 7% of their patients exhibited an increase in their pain intensity during the 6-day follow-up, we did not observe such a trajectory. The fact that the group-based trajectory modeling analysis tends to cluster a significant number of patients in each trajectory (>5%) and the longer follow-up period used in the present study probably explain the absence of such a pattern of increasing pain intensity.

We also established an association between the types of pain conditions and the pain trajectories. Musculoskeletal and fractures pain conditions were more associated with severe pain intensity trajectories and renal colic with lower pain intensity profiles. Renal colic pain is a singular phenomenon in pain resolution patterns because it generally alternates between episodic intense pain and periods with no pain until the stone is expelled. Despite those expected results, two thirds of patients with musculoskeletal pain will have resolved pain in a 14-day period, contrary to 61% of patients with a fracture, who will remain in moderate or severe pain during that length of

time. Chapman et al[4,5] found a similar association between the intercept or slope of pain trajectories and injury location or surgical sites.

Contrary to the results obtained by Chapman et al,[4,5] the average pain intensity at discharge observed in our study (numeric rating scale score 4.8) was lower than that reported by patients on the first day of the diary (numeric rating scale score 6.6). We decided not to include the pain intensity at ED discharge in the pain trajectory analysis because it was probably modulated by ED pain treatment. However, in our study, pain intensity at ED discharge was associated with the different pain trajectory groups; patients with higher pain intensity at ED discharge followed higher pain intensity trajectories more often. Pain during ED stay or at discharge has also been associated with chronic pain[27]; however, as demonstrated in the acute pain trajectories of Figure 2, some patients had high initial post-ED pain intensity values but their pain rapidly resolved with an exponential function to a complete recovery. Therefore, our findings suggest that some patients, as seen in their pain trajectories, may require more pain medication than others. Finding the risk factors associated with these pain trajectories would help refine outpatient pain management to ensure that patients are given an amount of pain medication suitable for their predicted pain course and possibly prevent chronic pain. Also, using trajectories may help identify these patients rapidly at different times during follow-up; for example, a patient with a numeric rating scale score greater than or equal to 8 on day 3 post-ED is 25 times more likely to follow a severe to severe trajectory than any other (data not shown).

Despite acute pain management that included opioids, almost 40% of patients had pain trajectories that remained of moderate to severe intensity after a 14-day follow-up. This result is disquieting because a recent study has shown that acute low back pain at 1 week was independently associated with impairment at 3 months (odds ratio 2.4) and moderate to severe pain (odds ratio 3.8).[28] Furthermore, because our follow-up was longer and pain at 2 weeks was more important (moderate or severe compared with some pain), we could presume that the association with impairment and moderate to severe pain at 3 months would be higher. Therefore, emergency physicians may consider adapting their pain management program for patients with significant pain at 14-day follow-up to prevent chronicization. A multicenter study to assess the relationship between pain trajectories and chronic pain would be useful.

In summary, acute pain resolution after an ED visit seems to progress through 6 different trajectory patterns identified by the group-based trajectory modeling method. After ED discharge with an opioid prescription, almost 40% of patients had trajectories that led to moderate or severe pain intensity at 14-day follow-up. Age, painful conditions, pain intensity at ED discharge, and opioid consumption were associated with the type of pain trajectory. These trajectories are more informative than simple linear models and could be useful in future research for the management of acute pain and for the early identification of patients at risk of chronic pain.

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