

Costs Associated with Intravenous Patient Controlled Analgesia (IV PCA) in US Hospitals

Schechter LN¹, Harshaw Q², Frye CB², Ernst FR³, Krukus MR³, Shillington AC²

¹Thomas Jefferson University Hospital, Philadelphia, PA; ²EPI-Q, Inc., Oak Brook, IL; ³Premier Healthcare Alliance, Charlotte, NC

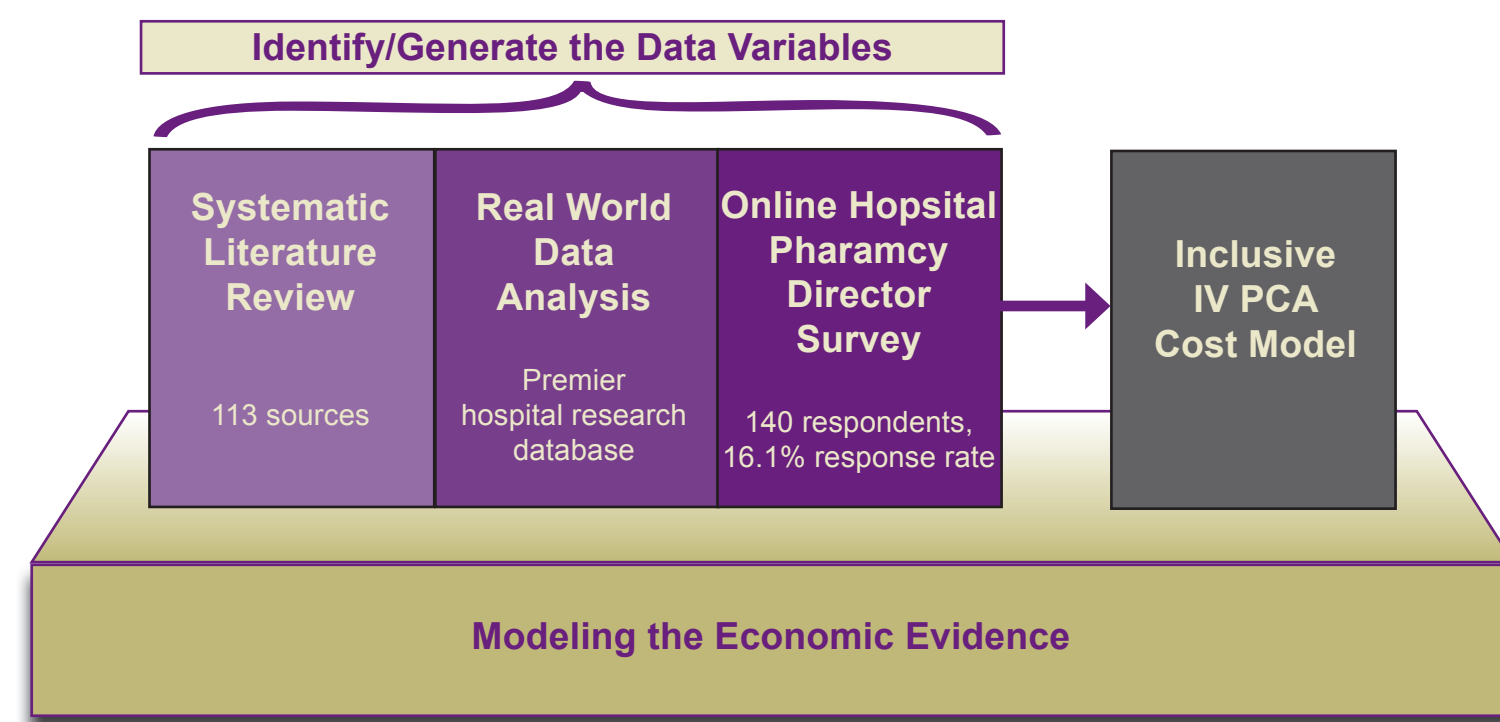
Background

- Effective post-operative pain management reduces pain intensity, improves patient satisfaction, reduces adverse events and expedites time to discharge.¹
- Multimodal analgesia is recommended for optimal pain management and improved patient outcomes.²
 - Includes both opioid and non-opioid analgesics.
 - Methods of administration include IV PCA, epidural, intrathecal, and intravenous bolus.
 - IV PCA is the cornerstone of moderate to severe post-operative pain management when an opioid is required.³
- There is high inter-patient variability in post-operative pain and PCA allows patients to manage their pain control while minimizing peaks and troughs of analgesic effect through self administration of small doses of analgesia on a frequent basis.³
- Currently available IV PCA technology has limitations including:⁴⁻⁸
 - Potential for programming and medication errors
 - Frequent monitoring required, especially for patients at risk for respiratory depression
 - Pump failures or malfunctions
 - Time consuming set up and programming
 - Restricted patient mobility with potential impact on length of stay (LOS)
 - Variable and considerable cost impact to hospitals
- The limitations may yield a higher cost of health care delivery.⁷

Objectives

To model IV PCA therapy costs in an inpatient, post-operative population.

Methods



The cost model parameters were obtained via:

- Online survey of 140 hospital pharmacy directors from an American Society of Health-System Pharmacists (ASHP) e-mail directory. The response rate was 16.1%.
- Analysis of the Premier hospital research database of 7 million inpatient surgical discharges, limited to Orthopedics, Gynecological, Colo-Rectal, Urological, and other General Surgery procedures where patients received IV PCA, from 2008-2011.
- Systematic literature review focusing on IV PCA related tasks and time motion studies.

Main Data Collected

- Hospital pharmacy directors survey
 - Key data elements were:
 - Drug cost
 - IV PCA pump-related costs
 - Non-drug supply costs
 - Premier hospital database
 - Key data elements included:
 - IV PCA prevalence
 - Demographics (e.g., age, gender/sex, diagnosis codes, surgical procedure)
 - IV PCA related complications and cost
 - Pharmacy costs
 - Outcomes
 - LOS
 - Systematic literature review
 - Identified cost variables and cost drivers
 - Extracted literature data for variables not otherwise collected

Analysis Methods

- Descriptive statistic analyses were conducted on surveys and Premier hospital research database. Means and standard deviations, as well as frequencies and percentages, were calculated based on the variables' attributes
- Bivariate analyses were performed using χ^2 or rank-sum test between categorical group of IV PCA patients and non-IV PCA patients
- Additional variables were extracted from publications found in the systematic literature review
- Regression analysis
 - Generalized linear models (GLM) - estimated associations between using IV PCA with hospital costs and length of stay while controlling for patient gender/sex, potential mobility related complications (such as respiratory depression, post-operative pneumonia, deep vein thrombosis (DVT), and pulmonary emboli (PE)), major surgical procedures, with and without controls for chronic conditions

Results: Pharmacy Directors Survey

- 38.6% respondents were from teaching hospitals and 61.4% were from non-teaching hospitals.
- 63.8% hospitals purchased IV PCA pumps; 21% leased or rented IV PCA pumps; 24% purchased and leased IV PCA pumps.
- Average number of IV PCA units per patient per day of agents were between 1.4 to 1.8 with SD (0.6-1.2).
- Mean cost per IV PCA drug unit dispensed were between \$7.82-\$11.86 (SD 2.75-8.91).
- Mean number of IV PCA days per patient were between 2.0 to 3.1 days (SD 0.67-2.41).

Results: Premier Database

- Approximately 4.3 million IV PCA patients and 2.4 million non-IV PCA patients were identified in the Premier database (Table 1).
- Mean age for IV PCA patients > for non-IV PCA patients (51.5 years vs. 45.1 years; Table 1).
- More IV PCA patients than non-IV PCA patients were male (29.7% vs. 22.4%; Table 1).
- Mean duration of IV PCA per post-surgical inpatient receiving IV PCA was 1.7 days (Table 2).
- Mean and median total hospital costs > IV PCA patients who had DVT, PE, or post-operative pneumonia than for non-IV PCA patients who had the same complications (Table 2).
- IV PCA patients had > hospitalization costs, even if they had no complications involving DVT, PE, or post-operative pneumonia.

Results: Literature Review

Abstracted overhead resource utilization related to use of IV PCA:

- Pharmacy, Nursing and other staff labor plus training costs
 - Pharmacist mean hourly wage +35% fringe benefits, \$72.79*
 - Pharmacy technician mean hourly wage with 35% fringe benefits, \$21.95*
 - Pharmacy labor attributable: \$13.17 per IV PCA patient day⁸
 - Nursing salary +35% fringe benefits, \$44.86/hour*
 - Nursing labor attributable: \$38.13 on day 1, and \$17.57 on day 2⁸
 - Central supply salary +35% fringe benefits, \$17.08/hour*
 - Central supply labor attributable: \$0.33 per IV PCA patient day⁸
- Equipment – time and cost assumptions
 - Life time of pump per unit of purchase – 7.9 years⁶
 - Life time of pump per unit of lease – 365 days (from pharmacy directors' survey)
 - Pump preparation between patients – 3-5 mins⁶
 - Outsourced pump maintenance contract cost \$145-\$225/year (from pharmacy directors' survey)
 - Pumps in use continuously 365 days a year (no downtime)
 - Assumed costs per patient for non-pump medical equipment⁹ used - \$22.44/patient (average costs obtained from wholesaler websites)

*Bureau of Labor Statistics, 2012

Results: Synthesized Data

- The mean cost per day of IV PCA was \$305.37 on day 1, and \$264.13 on day 2.
- Component mean costs per IV PCA day included (Table 4):
 - Pharmacy drug, \$19.66/day;
 - Nursing labor, \$38.13 on day 1, and \$17.57 on day 2;
 - Pharmacy labor, \$13.17/day;
 - PCA pump cost, \$5.24/day;
 - Error-related costs, \$19.71/day; and
 - Non-drug disposables, \$21.56 on day 1, and \$0.88 on day 2⁹
- Complications related to IV PCA added \$187.58 per IV PCA day, on average
 - Adjusted for baseline demographics and surgical procedure
 - Complications included DVT, PE, and post-operative pneumonia, which occurred in 2.1% of IV PCA patients vs. 1.6% of non-IV PCA patients
- IV PCA patients had a longer LOS after adjusting for baseline demographics and surgical procedures (p<0.0001)
 - Mean LOS, IV PCA: 4.53 days [95% CI 4.41-4.66]
 - Mean LOS, non IV PCA: 4.24 days [95% CI 4.12-4.35]

Results: Synthesized Data (continued)

Table 1. Premier Patient Demographics (2008-2011)

	IV PCA		No IV PCA	
	Discharges	%	Discharges	%
Total Discharges-Actual	6,679,596	100	4,300,160	100
Total Patients	5,979,704	100	3,862,431	100
Age, years				
18-34	2,293,476	34.34	1,243,818	28.92
35-44	827,060	12.38	520,419	12.10
45-54	745,712	11.16	529,899	12.32
55-64	912,838	13.67	647,111	15.05
65-74	920,651	13.78	658,487	15.31
75+	979,859	14.67	700,426	16.29
Mean	49.21		51.47	45.13
Standard Deviation	20.78		20.56	20.55
Median	48		52	38
Gender				
Female	4,868,092	72.88	3,021,501	70.26
Male	1,811,140	27.11	1,278,311	29.73
Unknown	364	0.01	348	0.01
Race/Ethnicity				
Black	790,876	11.84	480,105	11.16
Hispanic	314,064	4.70	245,956	5.72
Other	1,187,650	17.78	742,463	17.27
White	4,387,006	65.68	2,831,636	65.85

Table 2. Premier IV PCA vs. No IV PCA: Total Discharge Costs & Length of Stay by Categories

	Overall	DVT	PE	Post-Operative Pneumonia	No Complication
IV PCA					
Total Cost (\$)					
Mean	14,930	54,149	51,206	61,515	14,016
Standard Deviation	21,784	68,989	61,495	71,242	18,679
Median	9,672	32,485	31,675	39,597	9,459
LOS (Days)					
Mean	4.8	19.9	18.3	21.7	4.5
Standard Deviation	7.5	26.0	19.4	23.8	6.4
Median	3	14	12	16	3
No IV PCA					
Total Cost (\$)					
Mean	9,934	39,526	39,570	47,375	9,378
Standard Deviation	18,700	57,814	56,681	69,431	16,388
Median	5,466	20,629	23,912	26,687	5,402
LOS (Days)					
Mean	4.1	19.4	18.3	21.3	3.9
Standard Deviation	6.7	21.9	27.3	29.0	5.5
Median	3	14	12	15	3

References

- Viscusi ER. *Reg Anesth Pain Med*. 2008;33:146-58.
- Practice guidelines for acute pain management in the perioperative setting: American Society of Anesthesiologists Task Force on Acute Pain Management. *Anesthesiology*. 2012;116:248-73.
- Hudcova J, McNicol ED, et al. *Cochrane Database Syst Rev*. 2012;Issue 6.
- Hicks RW, Heath WM, et al. *Joint Comm J Qual Pat Safe*. 2008;34:734-42.

Table 3. Premier IV PCA Medication Use and Costs

	Volume of Use		Dose*		Total Hospital Costs (\$)		Length of Therapy (Days)	
	Discharges	%	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Total Discharges	4,300,160	100						
IV PCA Opioid Medication								
Buprenorphine	8,863	0.21	1.3	2.8	13,714	15,947	1.9	3.0
Fentanyl	3,457,379	80.40	724.6	6,743.8	15,393	22,904	1.2	1.4
Fentanyl/Droperidol	6,978	0.16	8.5	50.6	18,634	29,802	1.2	1.0
Hydromorphone	1,705,774	39.67	20.8	182.1	17,884	25,136	2.2	3.4
Meperidine	556,859	13.18	178.4	843.5	14,868	22,401	1.4	1.4
Morphine	2,352,024	54.70	44.5	584.8	16,723	24,858	2.1	2.8
TOTAL	4,173,525	97.06	—	—	15,122	22,004	2.4	3.6

*In milligrams (mg), except for fentanyl products which are listed on micrograms (mcg).

Table 4. Model Summary (Combined Data Sources)

	Cost per IV PCA Patient Day		Cost per IV PCA Patient		
	Day 1	Day 2	Mean	Min***	Max***
Drug/Supply Cost					
Pump Cost*	\$ 5.24	\$ 5.24	\$ 9.11	\$ 5.59	\$ 10.42
Non-Drug Disposables Cost ⁹	\$ 21.56	\$ 0.88	\$ 22.44	\$ 22.08	\$ 22.80
Pharmacy Drug Cost	\$ 19.66	\$ 19.66	\$ 34.20	\$ 3.19	\$ 505.18
Labor Costs					
Pharmacy	\$ 13.17	\$ 13.17	\$ 22.92	\$ 1.90	\$ 97.66
Nursing	\$ 38.13	\$ 17.57	\$ 55.70	\$ 44.56	\$ 66.84
Staff Training	\$ 0.33	\$ 0.33	\$ 0.57	\$ 0.45	\$ 0.68
Incremental Complication Costs					
DVT	\$ 10.44	\$ 10.44	\$ 18.17	\$ 14.53	\$ 21.80
PE	\$ 24.82	\$ 24.82	\$ 43.19	\$ 34.55	\$ 51.83
Post-operative Pneumonia	\$ 152.31	\$ 152.31	\$ 265.02	\$ 212.02	\$ 318.03
IV PCA Error Cost (MEDMARX) ⁷	\$ 19.71	\$ 19.71	\$ 34.29	\$ 27.44	\$ 41.15
Incremental Cost Over Non IV PCA	\$ 305.37	\$ 264.13	\$ 505.62	\$ 367.89	\$ 1,201.96
Incremental LOS Cost**			\$ 4,732.00	\$ 3,785.60	\$ 5,678.40
Overall Incremental Cost	\$ 305.37	\$ 264.13	\$ 5,237.62	\$ 4,153.49	\$ 6,880.36

*Including pump maintenance labor cost.

**Mean difference in total LOS cost (IV PCA/no IV PCA) adjusted for baseline patient demographics, procedures, complications.

***Min and Max are estimated based on either the original data min and max, or $\pm 20\%$ of the mean.

Conclusions

- This study demonstrates that IV PCA, while a mainstay of post-operative pain relief, is costly to hospitals and integrated health systems and represents a significant burden to the US healthcare system due to potentially dangerous medical and device errors.
- Less resource intensive PCA delivery would provide an alternative method for administering on-demand opioid therapy with potential benefits for both the patient and hospital.

Limitations

- The study relied on administrative hospital billing data and ICD-9 coding to identify patients and complications, which are subject to potential errors.
- The study employed results from a survey of hospital pharmacy directors, which may have provided subjective estimates rather than factual cost amounts.

Disclosure

Funded under a grant from Incline Therapeutics, Inc.

- Evans C, Schein J, et al. *Pain Manag Nurs*. 2007;8:86-95.
- Hutchison RW, Anastassopoulos K, et al. *Hosp Pharm*. 2007;42:1036-44.
- Meissner B, Nelson W, et al. *Hosp Pharm*. 2009;44:312-324.
- Mordin M, Anastassopoulos K, et al. *J Perianesth Nurs*. 2007;22:243-255.
- Chang AM, Ip WY, Cheung TH. *J Adv Nurs*. 2004;46:531-41.