

## **Appendix. Key Design Elements of Bundled Payments and Effects on Quality of Care and Medical Spending**

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**Table A1. Overview of Key Design Elements of Bundled Payment Models**

	Name [references]	Care Components	Payment Methodology	Accountable Entity		Period of Episode	Risk-Sharing Properties	Risk-Adjustment Methods	Distribution of Payment Among Participating Providers	Link with Quality
<b>UNITED STATES</b>										
1.	PROMETHEUS [1-3]	<p><i>Presurgery:</i> All costs excluded</p> <p><i>Inpatient stay:</i> All physician and hospital services</p> <p><i>Recovery:</i> Physician services, hospital services for complications, readmissions</p> <p>- Optional package: physical therapy, home health care (HHC)</p> <p>- Excluded: skilled nursing facilities, inpatient rehab, outpatient pharmacy, durable medical equipment</p> <p><i>Follow-up:</i> Physician services, hospital services for complications, readmissions</p> <p>- Excluded: physical therapy, HHC, skilled nursing facilities, inpatient rehab, outpatient pharmacy, durable medical equipment</p>	Retrospective bundled payment (category 3c)	Provider-led entity (hospital)		Different clinical episodes	Savings split between providers and payers (percentages not mentioned)	Yes, but not specified	Unknown	n/a
2.	Acute Care Episode (ACE) Demonstration [4-6]	<p>Inpatient stay for included 37 conditions (28 cardiac and nine orthopedic inpatient surgical services and procedures)</p> <p>All Part A and Part B Medicare services, including physician services, pertaining to inpatient stay for Medicare fee-for-service (FFS) beneficiaries</p>	Retrospective bundled payment (category 3c); each hospital negotiated its own discount from Medicare usual payments	Value-based care centers, which were provider-led hospitals (N=5)		Hospital admission	50/50 between payer and provider (after negotiated discount with Medicare) and capped at 25% of Medicare Part B allowable	Not described	Gain-sharing allowed between hospital and doctors; also for patients to offset their Medicare cost-sharing obligations	Yes; to share savings, participants must meet quality reporting and monitoring requirements
3.	UnitedHealth Care Episode payment model for oncology care [7-9]	<p>Physician hospital care, hospice management, case management</p> <p>Excluded (FFS-based): Physician office visit, chemotherapy administration, chemotherapy medications, diagnostic radiology, laboratory</p>	Prospective bundled payments (category 4a)	Hospital (MD Anderson for head and neck cancer)		Depends on stage of cancer and clinical path (4, 6, 9, or 12 months)	Stop-loss provision (1%) for head and neck cancer	Not described	Not described	Report
4.	IHA Bundled Episode Payment and Gainsharing Demonstration [10]	Facility, professional and medical implant device charges for the inpatient stay; 90-day postsurgical warranty for related complications and readmissions	Prospective bundled payments (category 4a)	Provider-led entity (hospital or independent practices)		Hospital admission through 90-day postdischarge period	Unknown	Unknown	Unknown	Unknown

	Name [references]	Care Components	Payment Methodology	Accountable Entity		Period of Episode	Risk-Sharing Properties	Risk-Adjustment Methods	Distribution of Payment Among Participating Providers	Link with Quality
5.	Minnesota Birth Centers BirthBundle (MBCBB) [11]	<i>Prenatal:</i> All prenatal checkups, ultrasounds, lab <i>Natal:</i> All services <i>Postpartum:</i> Newborn assessment 24 hours postpartum; postpartum visits (1-2 + 6 weeks); fee for birth center (for coordination activities) if hospital delivery	Retrospective bundled payment (category 3c)	Provider-led (one provider)		270 days before delivery through 56 days postpartum	100% risk-bearing providers	Unknown	Unknown	n/a
6.	Horizon HealthCare division (Blue Cross Blue Shield) [12]	Care episode broken into four stages: 1) the 30-day preoperative period 2) the acute hospital stay and related surgical costs 3) the first 30 days postoperatively 4) postoperative days 31–90	Retrospective bundled payment (category 3c)	Provider-led entity (hospital and orthopedic surgeons)		30 days preoperatively to 90 days postoperatively	One-sided, with cap on 115% of target spending; outlier episodes significantly over budget are protected at maximum of 115% of severity-adjusted budget	Patient severity adjusted budget for each episode determined utilizing PROMETHEUS grouper technology	Unknown	Unknown
7.	Hoag bundled payment for total joint arthroplasty [13]	All services associated with inpatient charges such as implants, in-hospital testing, inpatient pharmacy, all inpatient professional fees, radiology, consultations, and hospitalist treatment; all services related to readmission such as venous thromboembolic, diseases, and surgical site infections and all services associated with inpatient skilled rehabilitation	Retrospective bundled payments (category 3c)	Provider-led entity (hospital)		One year	100% risk-bearing providers	Unknown	Unknown	Unknown
8.	Providence Health & Services The Pregnancy Care Package (PHSPCP) [11, 14]	All prenatal care, including regular checkups, screening, counseling, psychosocial support  All natal care  All postpartum care for mother and newborn	Prospective bundled payments (category 4a)	Provider-led (one provider)		Positive pregnancy confirmation through 6 weeks postpartum	100% risk-bearing providers	Unknown	Unknown	n/a
9.	Bundled Payment for Care Improvement (BPCI) [6, 13, 15-47]	Differs among conditions and models	Differs among models (both retrospective bundled payment models (3c) and prospective bundled	Provider-led entities, mostly hospitals		Differs (between 0, 30, 60, and 90 days in postdischarge period)	Differs among models	Yes, but not specified	Differs among initiatives	Unknown

	Name [references]	Care Components	Payment Methodology	Accountable Entity		Period of Episode	Risk-Sharing Properties	Risk-Adjustment Methods	Distribution of Payment Among Participating Providers	Link with Quality
			payments (4a)							
10.	Bundled Payment for Care Improvement (BPCI) Advanced	Differs among conditions and models	Retrospective bundled payments (category 3c)	Provider-led entities, mostly hospitals		90 days	Two-sided (unknown distribution of shared risks)	Yes, but not specified	Unknown	Yes, after reconciliation
11.	Horizon Blue Cross Blue Shield of New Jersey (Horizon HealthCare Division) [12, 48]	All outpatient prenatal care All natal care Postpartum unknown	Retrospective bundled payment (category 3c)	Multiple provider-led organizations		Unknown	Unknown	Unknown	Unknown	n/a
12.	Comprehensive Care for Joint Replacement (CJR) Payment model [6, 35, 43, 49-52]	All care, including readmissions, up to 90-day postdischarge period	Retrospective bundled payment (category 3c)	Provider-led entity (hospital)		Initial admission till 90 days postdischarge	Hospitals that have FFS spending of more than target price are responsible for paying difference up to stop-loss amount (maximum financial penalty to the hospital)  Upside and downside risks increase over time: in first year, stop gain was +5%, with no downside risk; by fifth year, stop gain and stop loss were each scheduled to be 20% of target price	Calculated hospital target prices based on a blend of a hospital's historical standardized spending and regional historical standardized spending on lower extremity joint replacement (LEJR) episodes; prices in performance years 4 and 5 to be based on 100% regional pricing  Risks stratified by diagnosis and major comorbidities, allowing patients to move into another diagnosis group resulting in differing prices	Unknown	Yes, minimum composite quality score must be achieved to get savings paid

	Name [references]	Care Components	Payment Methodology	Accountable Entity		Period of Episode	Risk-Sharing Properties	Risk-Adjustment Methods	Distribution of Payment Among Participating Providers	Link with Quality
13.	Arkansas Health Care Payment Improvement Initiative (APII) [53, 54]	Depends on specific episode of care	Retrospective bundled payment (category 3c)	Principal accountable provider responsible for portion of any excess spending		Depends on specific episode of care	Unknown	Risk-adjusted based on documented patient comorbidities and historical benchmarks	Unknown	Yes, savings or losses depend on quality metrics
14.	HealthChoice Select [55]	Bundle is intended to cover all services on day of procedure and any standard global period services	Prospective bundled payments	Unknown		One year	Unknown	Unknown	Unknown	Unknown
15.	Humana/Century Oncology case rate [56, 57]	Each bundled cancer diagnosis is assigned a fixed payment to cover all direct radiation therapy expenses  21st Century Oncology provides services exclusively at its freestanding centers, rather than hospitals, thus the episodic payment provides compensation for technical and professional services  Indirect treatment expenses such as medications, laboratory tests, and diagnostic imaging are excluded	Prospective bundled payments (category 4a)	Provider-led entity (hospital)		Begins at consultation and end 90 days after treatment	100% risk-bearing hospital	PROMETHEUS model	Unknown	n/a
<b>OTHER COUNTRIES</b>										
16.	Bundled payment for breast cancer [58]	All services regarding intake, diagnosis and staging (imaging, biopsy, pathology), treatment (surgery, chemotherapy, radiation) and follow-up  Regular screenings fully reimbursable for women 50 to 69 years of age (with the exception of a small out-of-pocket payment) but not included in the bundle; for younger healthy women, screening was paid out of pocket	Retrospective bundled payments (category 3c)	Provider-led entity (hospital)		Depending on treatment, nine months to five years	100% risk-bearing providers	Unknown	Unknown	Maximum add-on payment of 10% of the bundled fee if quality and outcomes targets met; add-on payment went to a general hospital fund and did not affect providers' salaries

	Name [references]	Care Components	Payment Methodology	Accountable Entity		Period of Episode	Risk-Sharing Properties	Risk-Adjustment Methods	Distribution of Payment Among Participating Providers	Link with Quality
17.	Bundled payment for diabetes care (BPDC) [59]	<p>Generic diabetes care within the primary care setting</p> <p>All regular checkups including an annual extensive consultation and subsequent consultations related to diabetes, such as dietary counseling, eye exam, foot exam</p> <p>Face-to-face specialist care is excluded, but the consultation function of the specialist by the general practitioner (GP) is included</p>	Prospective bundled payments (category 4a)	Provider-led (GP)		365 days	100% risk-bearing GPs	Unknown	Unknown	n/a
18.	Bundled payment for diabetes care (BPDC), chronic obstructive pulmonary disease (COPD) care (BPCC) and vascular risk management (BPVRM) [60-63]	<p>Services to be included in generic care bundles have been described in disease-specific health care standards and set at the national level and agreed on by national associations of providers and patients</p> <p>Promoting self-management and individual care plans for patients are innovative elements in the standards</p> <p>Services in the care bundles are fully covered by basic insurance that is mandatory for all Dutch citizens, which means these services require no additional payment from patients</p> <p>The standards specify only the treatment activities; to encourage competition among providers, the standards do not specify the discipline of the provider who delivers the care</p>	Prospective bundled payments (category 4a)	Provider-led entities, most exclusively owned by GPs		365 days	100% risk-bearing providers	None, but the freely negotiable fees differ among contracts to reflect case-mix differences	Unknown	n/a
19.	Leading maternity Carer [64]	<p><i>Prenatal:</i> All prenatal care</p> <p><i>Natal:</i> All natal care</p> <p><i>Postpartum:</i> Complications during postpartum period including readmissions (related to delivery) for mother</p> <p><i>Exclusions:</i> Newborn care</p>	Prospective bundled payments (category 4a)	Caregiver: one provider		Positive pregnancy confirmation through six weeks postpartum	n/a	Unknown	n/a	n/a

	Name [references]	Care Components	Payment Methodology	Accountable Entity		Period of Episode	Risk-Sharing Properties	Risk-Adjustment Methods	Distribution of Payment Among Participating Providers	Link with Quality
20.	Portuguese bundled payment model for end-stage renal disease [65, 66]	Dialysis treatment; laboratory and imaging tests; all medication for treatment of anemia, bone mineral disease, nutrition, and cardiovascular comorbidities; intradialytic intravenous antibiotics and vascular access management  Patient transportation and hospitalization costs are not included	Prospective bundled payments (category 4a)	Hemodialysis providers		Fixed payment per week	100% risk-bearing providers	Unknown	Internal payment model with three parts: - Resource management (50% of incentive payment) - Clinical performance (40% of incentive payment) - Patient satisfaction (10% of incentive payment)	n/a
21.	OrthoChoice [67-69]	Preoperative visit, the operation (including prosthesis), inpatient care, and a follow-up visit within three months  All physician fees, personnel costs, drugs, tests, imaging, and other supplies  Outpatient rehabilitation not covered in the bundle  Bundle included a two-year warranty that held providers financially liable for complication related to the surgery, such as infection or need for revision or reoperation (hip dislocation excluded from warranty); if a patient had an infection in the two-year warranty period, the warranty expanded to five years	Prospective bundled payments (category 4a)	Provider-led entity (hospital)		From preoperative visit to end of warranty period (two or five years, depending on whether patient had a surgery-related complication )	100% risk-bearing providers	Unknown	Unknown	n/a
22.	Long-term care bundled payment, crossing health and social care [70]	Primary care, acute care, and community care	Prospective bundled payments (category 4a)	Not described		One year	Unknown	Yes, but not specified	Unknown	n/a
23.	Bundled payment for maternity care [70]	<i>Prenatal:</i> All prenatal care <i>Natal:</i> All delivery-related care <i>Postnatal:</i> Care for mother  <i>Excluded:</i> Care for newborn health problems	Prospective bundled payments (category 4a) with stratified modules (low, middle, high)	Provider-led (hospital)		10 weeks to 6 weeks postpartum	100% risk-bearing providers	Unknown	Unknown	n/a

**Table A2. Effect of Bundled Payments Reform on Quality of Care and Health Care Spending**

Study and Year	Bundled Payment Initiative	Research Methodology	Sample Size	Year of Data Collection	Impact on Quality of Care	Impact on Medical Pending
Urdapiletta et al., 2013 [4]	ACE payment model	Difference-in-difference approach with control groups	N=12,501 episodes of care (patient numbers unknown)	2007–12	<ul style="list-style-type: none"> <li>- Quality of care levels seemed to be maintained</li> <li>- Reduction in use of internal mammary artery grafts in patients undergoing coronary artery bypass graft (CABG) surgery</li> <li>- Short duration of the demonstration may have made it difficult to observe quality improvements</li> </ul>	<ul style="list-style-type: none"> <li>- Savings of \$319 per episode</li> <li>- Total of \$4 million in net savings for 12,501 episodes of care</li> </ul>



Chen et al., 2018 [5]	ACE payment model	Difference-in-difference approach, matching on baseline and pre-enrollment volume, risk-adjusted Medicare payments, and clinical outcomes	ACE: 10462 Non-ACE: 42312	2007–12	<ul style="list-style-type: none"> <li>- No significant association with 30-day mortality for: Orthopedic surgery: -0.10 (95% CI: -0.50, 0.31) Cardiac surgery: -0.27 (95% CI: -1.25, 0.72)</li> </ul>	<ul style="list-style-type: none"> <li>- No significant association with 30-day Medicare payments: for orthopedic surgery: \$358 (95% CI: -\$894, +\$178) for cardiac surgery: +\$514 (95% CI: -\$1,517 - +\$2,545)</li> <li>- Associated with a decrease in total 30-day post-acute care payments: for cardiac surgery: -\$718 (95% CI: -\$1,431, -\$6) for orthopedic surgery: -\$591 (95% CI: \$1,161, -\$22)</li> </ul>
Lawler et al., 2017 [55]	HealthChoice Select	Retrospective study with control group	Intervention: 7,900 procedures for 5,907 patients	January 1, 2016, through December 31, 2016	<ul style="list-style-type: none"> <li>- Patients in the Select system who had outpatient procedures had significantly fewer subsequent claims than those not in Select for hospitalization (1.7% vs. 2.5%, respectively) and emergency department visits in the 30 days post-procedure (4.4% vs. 11.5%)</li> <li>- Quality measures were similar for patients who were and were not in Select group</li> <li>- Surgical complication rates were higher for Select group</li> </ul>	<ul style="list-style-type: none"> <li>- Allowable costs were similar for bundled procedures at ambulatory surgery centers and at outpatient hospital facilities; allowable costs for patients not in Select program (mean, \$813) were lower at ambulatory surgery centers than at outpatient hospital departments (mean, \$3,086) because of differences in case mix</li> </ul>
Newcomer et al., 2014 [7]	UnitedHealthcare episode payment model for oncology care	Observational prospective study with pre- and post-measurement	N=810 (not specified in pre- and post-intervention )	Pre-intervention period: October 2006 to July 2009 Post-intervention period: October 2009 to December 2012	<ul style="list-style-type: none"> <li>- No differences between groups on multiple quality measures</li> </ul>	<ul style="list-style-type: none"> <li>- A 34% reduction of predicted total medical cost (\$33 million total)</li> <li>- Study used two interventions — financial incentives and data-sharing — to change behavior; not possible to determine the relative effect of each incentive</li> </ul>
Doran et al., 2015 [12]	Horizon Health Care division (Blue Cross Blue Shield)	Not described	Total knee arthroplasty (TKA) N=204 (2011) and N=357 (2013-2014)  Total hip arthroplasty (THA) N=104 (2011) N=202 cases (2013-2014).	Pre-intervention period: 2011 Post-intervention period: October 2013 to September 2014	<ul style="list-style-type: none"> <li>- TKA length of stay (LOS) decreased from 3.3 days to 1.9 days</li> <li>- THA LOS decreased from 2.9 days to 1.8 days</li> <li>- Discharge to inpatient rehabilitation significantly decreased from 66.3% in 2011 to 33.17% in 2013–14</li> <li>- In-hospital complication rate increased from 6.4% to 8.67%, but a review of this data revealed a significant increase in hospital coding for clinically insignificant complications</li> <li>- Transfusion rate decreased from 23.2% to 4.45%</li> <li>- 30-day readmission rates decreased from 3.2% to 2.7%</li> <li>- Deep infection and major wound</li> </ul>	<ul style="list-style-type: none"> <li>- Average device cost decreased from \$6,301 per patient to \$4,972 per patient with the last six months averaging \$4,585 per patient</li> <li>- Average episode budget was \$25,365 for TKA and \$23,580 for THA</li> <li>- Under budget for 65 of 78 TKA episodes and under budget for 27 of 38 THA episodes</li> <li>- Total savings relative to budget for all Horizon patients over this two-year period exceeded \$524,000, resulting in a savings of \$262,445 during this time or an average of \$2,262 per patient</li> </ul>

					<p>complication rates remained low at 0.9%</p> <ul style="list-style-type: none"> <li>- Hospital TJA service line HCAHPS score was in the 80.9 percentile and the likelihood to recommend the hospital was 89.7%</li> <li>- Likelihood to recommend the surgeon was 94.4%; WOMAC average percent score improvement was 76%</li> </ul>	
Froemke et al., 2015 [22]	Bundled Payment for Care Improvement (BPCI)	Retrospective observational study with pre- and post-measurement	Pre-pilot N=351; Pilot N=317	<p>Pre-pilot cohort (Jan. 1 through Dec. 31, 2010)</p> <p>Pilot cohort (June 1, 2012, to Feb. 28, 2013)</p>	<ul style="list-style-type: none"> <li>- 18% reduction in LOS</li> <li>- Shift from home health and skilled nursing facility discharge to home self-care (54.1% to 63.7%)</li> </ul>	<ul style="list-style-type: none"> <li>- No significant differences in implant cost</li> <li>- Improvements resulted in 6% reduction in average total allowed claims per case</li> </ul>
Whitcomb et al., 2015 [26]	Unclear (BPCI?)	Retrospective observational study with pre- and post-measurement	<p>Pre-intervention: N=32</p> <p>Post-intervention period: N= 45</p>	<p>Pre-intervention 2009–10</p> <p>Post-intervention 2011</p>	<ul style="list-style-type: none"> <li>- Post-intervention patients were more likely to be discharged directly to home than to a rehabilitation facility (63% vs. 87% discharged home, <math>P=0.03</math>)</li> <li>- Mean LOS decreased from 3.4 days in baseline period to 3.0 days during pilot (<math>P=0.24</math>)</li> <li>- Adherence to a composite of Surgical Care Improvement Project process measures increased from 95% to 99% (<math>P=0.05</math>)</li> <li>- In pre-intervention and post-intervention period: no readmissions at 30 days, no deaths, and no identified episodes of surgical site infection, urinary tract infection, complications of anesthesia, or postoperative sepsis</li> </ul>	<ul style="list-style-type: none"> <li>- Median total cost per case decreased from \$26,412 during baseline period to \$22,567 during bundle period (<math>P=0.0001</math>)</li> <li>- After adjustment for changes in DRG weight, adjusted median cost per case did not show a significant change; it was \$22,272 during baseline period and \$22,567 during bundle pilot (<math>P=0.43</math>)</li> </ul>
Althausen et al., 2016 [15]	BPCI model 2	Not specified	Not specified	2015–16	Not measured	<ul style="list-style-type: none"> <li>- Hospitals saved \$1,919,247, incurred from both BPCI and non-BPCI patients because programs from BPCI positively affect all patients secondary to improved algorithms, cost control, and case management</li> <li>- Average savings per case was \$1,969 for arthroplasty cases and \$975 for hip and femur fracture cases</li> <li>- Net payment reconciliation payments from the initiative to the practices totaled \$838,000 and were allocated to reduce group overhead</li> <li>- \$136,000 was lost because of not reaching quality metrics in each quarter (not specified)</li> </ul>

lorio et al., 2016 [71]	BPCI (model 2: TJR)	Pre- and post-measurement	N=721 during intervention period	January 1, 2013, to January 5, 2014, with risk phase starting October 1, 2013  Baseline period for spending comparison: July 2009 to June 2012	<ul style="list-style-type: none"> <li>- Average LOS was decreased from 4.27 days to 3.58 days (median LOS 3 days)</li> <li>- Discharges to inpatient facilities decreased from 71% to 44%</li> <li>- Readmissions occurred in 80 patients (11%), slightly lower than before implementation</li> </ul>	<ul style="list-style-type: none"> <li>- Early results from implementation of primary total joint arthroplasty (TJA) program demonstrate cost savings up to 10% within the first two-quarter claims</li> </ul>
Preston et al., 2018 [45]	BPCI: TJA	Retrospective study	Intervention: N=332  Baseline: N=582	Pre-intervention: July 2009 to June 2012  Post-intervention: July 2015 to September 2016	<ul style="list-style-type: none"> <li>- Hospital LOS decreased from 4.9 to 3.5 days (<math>P=0.02</math>)</li> <li>- All-cause 90-day readmission rates decreased from 14.5% to 8.2% (<math>P=0.0078</math>)</li> <li>- Discharges to home increased from 11.6% to 49.8% (<math>P=0.005</math>)</li> </ul>	<ul style="list-style-type: none"> <li>- Total reduction in cost per episode for TJA was 20.0% (<math>P=0.10</math>)</li> </ul>
Odum et al., 2018 [39]	BPCI model 2 TCA	Retrospective cohort study	Intervention: N=333  Control: N=132	Pre-intervention: 2009–12 Post-intervention: 2015	Residential facility (RF) and skilled nursing facility (SNF) utilization and 90-day readmission rate significantly decreased	<ul style="list-style-type: none"> <li>- 4% decrease in expenditures (<math>P=0.08</math>) after controlling for post-acute events in multivariate regression model</li> </ul>

Joynt Maddox et al., 2018 [29]	BPCI: congestive heart failure (CHF), pneumonia, chronic obstructive pulmonary disease, sepsis, and acute myocardial infarction	Difference-in-difference	BPCI hospitals: 492; matched control non-BPCI hospitals: 898; all non-BPCI hospitals: 3,681	2013–15	<ul style="list-style-type: none"> <li>- Changes from baseline to intervention period in clinical complexity, LOS, emergency department use or readmission within 30 or 90 days after hospital discharge, or death within 30 or 90 days after admission did not differ significantly between the intervention and control hospitals</li> </ul>	<ul style="list-style-type: none"> <li>- Average Medicare payment per episode of care across five conditions at BPCI hospitals was \$24,280 (baseline), which decreased to \$23,993 during intervention period (difference, -\$286; <i>P</i>=0.41)</li> <li>- Control hospitals had average payment for all episodes of \$23,901 at baseline, which decreased to \$23,503 during intervention period (difference, -\$398; <i>P</i>=0.08)</li> <li>- Difference in differences, \$112; <i>P</i>=0.79)</li> </ul>
Doran et al., 2015 [12]	BPCI for TJA	Unknown	Unknown	<p>Baseline: 2011</p> <p>Intervention: October 2013 to September 2014</p>	<ul style="list-style-type: none"> <li>- Discharge to inpatient rehabilitation significantly decreased from 66.3% in 2011 to 33.17% in 2013–14</li> <li>- In-hospital complication rate increased from 6.4% to 8.67%, but a review of data revealed a significant increase in hospital coding for clinically insignificant complications, including transient hypotension, transient urinary retention, and transient laboratory alterations in renal function</li> <li>- Transfusion rate decreased from 23.2% to 4.45% and 30-day readmission rates decreased from 3.2% to 2.7%</li> <li>- Deep infection and major wound complication rates remained low at 0.9%</li> <li>- Patient satisfaction and functional outcome scores exhibited high patient satisfaction rate and significant functional improvement</li> </ul>	<ul style="list-style-type: none"> <li>- Total savings over 2-year period exceeded \$524,000, resulting in a savings-based payment to participating orthopedic group of \$262,445 during this time or an average of \$2,262 per patient</li> </ul>
Courtney et al., 2016 [19]	BPCI	Pre-post intervention (with control group but no matching procedure)	<p>Intervention N=91;</p> <p>Controls N=126</p>	2013–15	<ul style="list-style-type: none"> <li>- LOS in group that underwent surgery before bundled-care arrangement was longer than for patients whose procedures were done under BPCI (mean 4.02 [SD, 3.0 days] versus mean 5.27 days [SD, 3.6 days]; <i>P</i>=0.001)</li> </ul>	<ul style="list-style-type: none"> <li>- No difference in episode-of-care costs</li> </ul>

Alfonso et al., 2017 [47]	BPCI (models 2 and 3)	Pre-post intervention with control group (model 2 compared to model 3)	<p>Model 2: 1,905 episodes for provider A and 5,410 episodes for provider B</p> <p>Model 3 (MS-DRGs 469 and 470): Provider A: N=1,680 episodes Provider B: N=3,298 episodes</p>	2009–12	<p>Model 2:</p> <ul style="list-style-type: none"> <li>- Increased percentage of discharge to HHC from 28% to 66%</li> <li>- Decreased discharge percentage to institutional PAC providers (SNF, inpatient rehabilitation facility [IRF], or LTCH) from 72% to 34%</li> <li>- Increased LOS from 15.0 to 22.1 days</li> <li>- Increased length of engagement for HHC from 15.7 to 22.3 days</li> </ul> <p>Model 3:</p> <ul style="list-style-type: none"> <li>- Increased discharge percentage to HHC from 17% to 22%</li> <li>- Decreased discharge percentage to institutional PAC providers from 83% to 78%</li> <li>- Reduced PAC provider LOS from 16.9 to 12.2 days</li> </ul> <p>Both models:</p> <ul style="list-style-type: none"> <li>- Readmission rates decreased for both institutions; provider A's readmissions decreased from 13% to 6.4%, while provider B's decreased from 12.8% to 9.2%</li> </ul>	<p>Model 2: Participant reduced average cost of all episodes by 18.45%, with all savings occurring in post-acute phase</p> <p>Model 3: Participant reduced episode costs by 16.73%</p>
Curtin et al., 2017 [33]	BPCI (orthopedic surgery)	Retrospective pre-post analysis	<p>Pre-intervention: N=8,415</p> <p>Post-intervention: N=4,757</p>	<p>Pre-intervention: 2009–12</p> <p>Post-intervention: 2015</p>	<ul style="list-style-type: none"> <li>- BPCI patients had a lower rate of:             <ol style="list-style-type: none"> <li>1) Subacute nursing facility admissions non-BPCI 43% vs. 37% BPCI; <math>P&lt;0.001</math>)</li> <li>2) IRF admissions (non-BPCI 3% vs. 4% BPCI; <math>P&lt;0.005</math>)</li> <li>3) HH (non-BPCI 79% vs. 73% BPCI; <math>P&lt;0.001</math>)</li> <li>4) Readmissions (non-BPCI 12% vs. 10% BPCI; <math>P&lt;0.02</math>)</li> </ol> </li> <li>- Changes in LOS for postacute care were only significant for HH with BPCI patients using a median 12 days and non-BPCI using 24 days</li> </ul>	<ul style="list-style-type: none"> <li>- Median expenditure for non-BPCI patients was \$22,193 compared to \$19,476 for BPCI patients (<math>P&lt;0.001</math>)</li> <li>- Median postacute care spend was \$6,861 for non-BPCI and \$5,360 for BPCI patients (<math>P&lt;0.001</math>)</li> </ul>

Carroll et al., 2018 [53]	APII for perinatal care	Difference-in-difference	Pre-intervention: N=2,454 (intervention); N=20,824 (controls)  Post-intervention: N=1,737 (intervention); N=15,291 (controls)	Pre-intervention: 2010–12  Post-intervention: 2013–14	<ul style="list-style-type: none"> <li>- Limited improvement in quality of care under evidence-based practice (EBP): out of seven outpatient care measures, only an increase in utilization of one screening test</li> </ul>	<ul style="list-style-type: none"> <li>- Perinatal spending decreased by 3.8% overall under EBP, compared to surrounding states</li> <li>- Decrease was driven by reduced spending on nonphysician health care inputs, specifically prices paid for inpatient facility care</li> </ul>
Bronson et al., 2018 [30]	BPCI (model 2)	Retrospective analysis (pre-post)	Intervention: N=350  Control: N=518	Pre-intervention: 2009–12  Post-intervention: 2013–14	<ul style="list-style-type: none"> <li>- LOS decreased (4.58 +/- 2.51 vs. 5.13 +/- 3.75; <math>P=0.009</math>)</li> <li>- Readmission rate unchanged</li> <li>- Discharges with home health aide increased</li> </ul>	<ul style="list-style-type: none"> <li>- No effect on episode-based cost savings</li> </ul>
Lichkus et al., 2017 [28]	BPCI for acute CHF exacerbations at a safety net community hospital	Pre-post retrospective cohort analysis	Before: N=316  After: N=283	Pre-intervention: October 1, 2013, to June 30, 2015  Post-intervention: July 1, 2015, to March 2017	<ul style="list-style-type: none"> <li>- Admission to skilled nursing facilities decreased from 21.3% to 16% after bundle implementation</li> <li>- Readmission rate was not significantly different but trended downward</li> <li>- Average number of days per quarter that patients stayed at an SNF decreased from 31.4 to 28.7</li> <li>- Number of patients discharged to SNF decreased from 14.57 to 9.14 (<math>P=0.0213</math>)</li> </ul>	<ul style="list-style-type: none"> <li>- Over 21-month study period, LGH had a positive margin of more than \$700,000 in the bundle; after splitting savings with convener and paying administrative fee, LGH received more than \$200,000</li> </ul>
Kee et al., 2017 [31]	BPCI (model unclear) and Arkansas Payment Improvement (API)	Retrospective study with control groups	BPCI: N=306  API: N=248;  Non-bundled: N=157	Study period: April 2013 to April 2015	<ul style="list-style-type: none"> <li>- Over entire 2-year study, primary THA readmission rate was 10.4% in BPCI group, 5.6% in API group, and 3.7% under non-bundled payment (<math>P&lt;0.01</math>)</li> <li>- Discharge home was 97.1% in BPCI group, 99.6% in API group, and 100% in non-bundled payment group (<math>P&lt;0.05</math>)</li> <li>- Average LOS was 1.23 days in BPCI group, 1.07 days in API group, and 1.08 days in non-bundled payment group (<math>P&lt;0.42</math>)</li> <li>- After primary TKA, readmission rate was 4.4% in BPCI group, 6.7% in API group, and 5.3% under non-bundled payment</li> <li>- Rate of discharge to home was 98.9% in BPCI group, 99.5% in API group, and 98.8% under non-bundled payment group (<math>P&lt;0.71</math>)</li> <li>- Average LOS was 1.25 days in BPCI group, 1.08 days in API group, and 1.23</li> </ul>	Not measured

					days under non-bundled payment group ( $P<0.38$ )	
Jubelt et al., 2017 [32]	BPCI (model 2) for lower extremity joint replacement (LEJR)	Difference-in-difference	Intervention: N=2,940 episodes  Control: N=1,474 episodes	Pre-intervention: April 2011 to June 2012  Post-intervention: October 2013 to December 2014	Not measured	<ul style="list-style-type: none"> <li>- LEJR: Relative to the trend in control group, LEJR episodes achieved the greatest savings in adjusted average episode cost during intervention period; it decreased by \$3,017 (95% CI, -\$6,066 to \$31)</li> <li>- Cardiac procedures: Adjusted average episode cost decreased by \$2,999 (95% CI: -\$8,103 to \$2,105)</li> <li>- Spinal fusion: Increase of \$8,291 (95% CI: \$2,879 to \$13,703)</li> <li>- Savings driven predominantly by shifting postdischarge care from inpatient rehabilitation facilities to home; spinal fusion index admission costs increased because of changes in operative technique</li> </ul>
Martin et al., 2017 [27]	BPCI for lumbar fusion (model 2)	Retrospective analysis with control groups	Risk-bearing hospitals; preparing hospitals and nonparticipating hospitals (N=89,605 beneficiaries)	Pre-intervention: 2012  Post-intervention: 2013	<ul style="list-style-type: none"> <li>- Relative to non-participants, risk-bearing hospitals had:</li> <li>- Slightly increased fusion procedure volume: 3.4% increase vs. 1.6 decrease, <math>P=0.119</math></li> <li>- Increased 90-day readmission rate (+2.7% vs. -10.7%, <math>P=0.043</math>)</li> <li>- Increased repeat surgery rates (+30.6% vs +7.1%, <math>P=0.043</math>)</li> </ul>	<ul style="list-style-type: none"> <li>- Relative to non-participants, risk-bearing hospitals did not reduce any 90-day episode of care cost (0.5% decrease vs 2.9% decrease [<math>P=0.044</math>])</li> </ul>
Bhatt et al., 2017 [16]	BPCI (model 2)	Pre-post intervention study (with control group but no matching procedure)	Intervention: N=78  Control: N=109	Pre-intervention: 2012  Post-intervention: 2014	<ul style="list-style-type: none"> <li>- No difference in all-cause readmission rates at 30 days (BPCI, 12 events [15.4%] vs. non-BPCI 19 [17.4%]; <math>P=0.711</math>), and 90 days 21 (26.9%) vs. 37 (33.9%), <math>P=0.30</math></li> </ul>	<ul style="list-style-type: none"> <li>- A 4.3% cost savings compared with BPCI target prices; however, this does not include costs incurred to support the program, which far exceeded this benefit according to the authors</li> </ul>
Dummit et al., 2016 [20]	BPCI (model unclear)	Difference-in-difference analysis with propensity score matching	176 BPCI participating hospitals and 915 matched non-BPCI-hospitals  BPCI hospitals had 29,441 episodes at baseline and	Pre-intervention: 2011–12  Post-intervention: 2013–15	<ul style="list-style-type: none"> <li>- No statistical differences in claims-based quality measures, which included:</li> <li>- 30-day unplanned readmissions (-0.1%; 95% CI -0.6% to 0.4%)</li> <li>- 90-day unplanned readmissions (-0.4%; 95% CI -1.1% to 0.3%)</li> <li>- 30-day emergency department visits (-0.1%; 95% CI -0.7% to 0.5%)</li> <li>- 90-day emergency department visits (0.2%; 95% CI -0.6% to 1.0%)</li> <li>- 30-day post discharge mortality (-0.1%; 95% CI -0.3% to 0.2%)</li> </ul>	<ul style="list-style-type: none"> <li>- Mean Medicare episode payments declined by an estimated \$1,166 more (95% CI, -\$1,634 to -\$699; <math>P&lt;0.001</math>) for BPCI episodes than for comparison episodes</li> <li>- Savings primarily due to reduced use of institutional postacute care</li> </ul>

			31,700 at year 3  Control group had 29,441 episodes at baseline and 31,696 at year 3		- 90-day post discharge mortality (-0.0%; 95% CI -0.3% to 0.3%)	
Greenwald et al., 2016 [23]	BPCI (model 2)	Observational retrospective study with a pre-post measurement	N=272 (DRG 470)	2013–14	- Percentage of patients in SNFs reduced from baseline of 69% to 22% - Readmission rates declined from 4.8% to 1.9% - Infection rates dropped from 5.2% to zero - LOS (days) decreased from 3.4 to 3.1	- Reduction of \$487,000, resulting in net reconciliation payment of \$330,000
Dundon et al., 2016 [49]	BPCI (model 2)	Observational study with two measurements in year 1 and year 3 in post-intervention period	Year 1: N=721  Year 3: N=785	2013–15	- LOS (days) from 3.58 (year 1) to 2.96 days (year 3) - Discharge to IRF from 44% to 28% - 30-day all-cause readmission from 7% to 5% - 60-day all-cause readmissions from 11% to 6% - 90-day all-cause readmissions from 13% to 8%	- Average costs to Centers for Medicare and Medicaid Services (CMS) per episode of care decreased by 20% - Largest CMS cost decrease was an 88% reduction in inpatient rehabilitation costs per episode of care by third quarter of 2014 - HHC costs increased by 23%
Navathe et al., 2017 [6]	BPCI and ACE	Observational with four periods: 1) ACE baseline period July 2008 to December 2008 2) ACE period July 2009 to June 2012 3) Transition period July 2012 to September 2013 4) BPCI period October 2013 to June 2015	N=3,942 (DRG 469 and 470)	2008–15	- Readmissions declined 1.4% ( $P=0.14$ ) - Emergency visits declined 0.9% ( $P=0.98$ )	- Average episode expenditures declined 20.8% for episodes without complications - Average episode expenditures declined 13.8% for episodes with complications
Finkelstein et al., 2018 [52]	CJR for LEJR episodes	RCT (after 1 year)	Randomization of MSAs into the CJR bundled payment	April 2016 to December 2016	- Mean percentage of LEJR admissions discharged to institutional postacute care was 33.7% (SD, 11.2%) in control group and 2.9 percentage points lower (95% CI, -4.95 to -0.90; percentage	- Mean Medicare spending for institutional postacute care per LEJR episode was \$3,871 (SD, \$1,394) in the control group and \$307 lower (95% CI, -\$587 to -\$27; $P=0.04$ ) in



			model group (75 assigned; 67 included) or to control group without CJR model (121 assigned; 121 included)		points: $P=0.005$ ) in CJR group	CJR group - Mean overall Medicare spending per LEJR episode was \$22,872 (SD, \$3,619) in control group and \$453 lower (95% CI, -\$909 to \$3: $P=0.06$ ) in CJR group
Loy et al., 2016 [57]	Humana/Century oncology case rate	Observational retrospective study	N=948 patients  Pre-intervention: N=433  Post-intervention: N=515	2011–13	<ul style="list-style-type: none"> <li>- No significant changes in guideline-based care in breast, lung, and skin cancer patients</li> <li>- Patients with bone metastases and prostate cancer were significantly more likely to have received guideline-based care (RR = 2.0 and 1.1, respectively, <math>P&lt;0.05</math>)</li> <li>- For aggregate of all cancers, undertreatment rate significantly declined (<math>P=0.008</math>) from 4% to zero after introduction of case rate payments, while overtreatment rate remained steady at 9%, with no significant change (<math>P=0.20</math>)</li> </ul>	Not measured
Busse and Stahl, 2012 [60]	Bundled payment for diabetes care	Pre-post measurement (without comparison group for quality, with control group for spending)	Not specified	2008–11	<ul style="list-style-type: none"> <li>- Decrease in specialist care</li> <li>- Increase in regular checkups</li> <li>- Increase in foot exams</li> <li>- Increase in kidney exams</li> <li>- Decrease in eye exams</li> </ul>	<ul style="list-style-type: none"> <li>- Increase in total medical spending of EUR 388 compared to control group</li> <li>- No increase in medical spending for diabetes specialist care</li> </ul>
Mohnen et al., 2015 [61]	Bundled payment for diabetes care	Observational retrospective study with a pre-post measurement with control group for spending  Multilevel regression analyses	N=64,001  Intervention: N=20,257  Control group 1 (MF) N=13,611  Control group 2 (CAU) N=30,143	Pre-intervention: 2008  Post-intervention: 2009 (1-year follow-up)	Not measured	<ul style="list-style-type: none"> <li>- Increase in total medical spending of \$369 compared to control group (<math>P&lt;0.0001</math>)</li> </ul>
Ponce et al., 2013 [65]	ERSD (Portugal)	A retrospective observational study including a pre-post measurement		January 2008 to December 2010  Pre-intervention 2008 Q1	<ul style="list-style-type: none"> <li>- Improvements were observed over time for all included clinical targets, except for target of ferritin</li> </ul>	<ul style="list-style-type: none"> <li>- Annual cost of dialysis care in non-public sector was around EUR 33,500 in 2009 and fell to EUR 30,000 at end of 2011</li> <li>- Without taking inflation into account,</li> </ul>

				Post intervention 2008 Q2 to end 2010		this 2009–11 change constituted a cost of care savings of 10.5%
Porter et al., 2014 [67]	Orthochoice	Pre-post measurement (without comparison group)	Unknown	2008–11	<ul style="list-style-type: none"> <li>- Complication rates dropped 16.9% in first year of implementation and another 25.9% in second year</li> <li>- No statistical difference regarding patient experiences and quality of life</li> <li>- Preoperative sick leave dropped from 50 days in 2008 to 39 days in 2010</li> </ul>	<ul style="list-style-type: none"> <li>- Per-procedure cost for all hip and knee replacements fell 17% in 2011 compared to 2008, primarily due to providers receiving a lower average price</li> </ul>
Wang et al., 2017 [58]	Bundled payment for breast cancer	Retrospective observational study including a pre-post measurement with a propensity score matched control group	N=17,940  Intervention: N=4,485  Control: N=13,455	January 2004 to December 2013  Inclusion period January 2004 to December 31, 2008, with a five- year follow-up period	<ul style="list-style-type: none"> <li>- In the intervention group, 1,473 of 4,215 patients (34.9%) with applicable quality indicators had full (100%) adherence to quality indicators compared with 3,438 of 12,506 patients (27.5%) with applicable quality indicators in the control group (<math>P&lt;0.001</math>)</li> <li>- Five-year event-free survival rates for patients with stages 0 to III breast cancer were 84.48% for bundled payment group and 80.88% for FFS group (<math>P&lt;0.01</math>)</li> </ul>	<ul style="list-style-type: none"> <li>- Although the five-year medical payments of bundled-payment group remained stable, the cumulative medical payments for control group steadily increased from \$16,000 to \$19,230 and exceeded pay-for-performance bundled payments starting in 2008</li> </ul>

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