Bundled Payment Models for Actinic Keratosis Management

Joslyn S. Kirby, MD, MS, MEd; Amber Delikat, BS; Douglas Leslie, PhD; Jeffrey J. Miller, MD, MBA

IMPORTANCE Recent legislation encourages alternative payment models, such as bundled payments. There are no clear recommendations on bundled payment design, and research on bundled payments for dermatologic care is limited.

OBJECTIVE To investigate several methods to develop bundled payment models for actinic keratosis (AK) management and the likely effect on the cost of AK management.

DESIGN, SETTING, AND PARTICIPANTS Cohort cost identification study using claims from Highmark Insurance and the MarketScan Commercial Claims and Encounters databases. Patients with claims for AK during the study period, January 2010 to December 2012, were included (N = 118,129). Utilization measures, such as visits and procedures, and direct costs were calculated and 8 bundled payment models were developed. Indirect costs were not included.

MAIN OUTCOMES AND MEASURES The actual health care costs and theoretical cost differences for the bundled payments. Costs are reported in 2012 US dollars and were adjusted for inflation. The proportion of patients and clinicians with annual AK claim costs less than or equal to the bundled payments were calculated.

RESULTS Eight bundled payment models were developed and 2, based on the 75th percentile payment, did not result in theoretical savings for any of the patient samples (increased annual spending of $1.04 million to $6.88 million). The median-based payment without adjustments resulted in the largest theoretical savings (decreased spending of $2.22 million to $6.43 million). In contrast, the mean-based payment with adjustments resulted in the smallest theoretical savings. The median-based with indirect payment (65.2% for patients and 62.0% for clinicians) and mean-based adjusted payments, with (68.9% and 66.2%) and without (68.1% and 65.6%) discount, were equal to or greater than the actual health care costs for similar proportions of patients and clinicians, respectively. In addition, both resulted in a decrease in overall health care costs for the patient cohort.

CONCLUSIONS AND RELEVANCE It is important to consider alternative payment models, such as bundled payments, in preparation for payment reform. The dermatology profession needs to understand disease management in dollar terms to advocate on behalf of clinicians and patients for fair and reasonable reimbursement, regardless of payment type.

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Bundled payment models are a novel payment method encouraged by the Affordable Care Act. In 2015, the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) was signed into law. This law supports implementation of alternative payment models, especially with expansion to specialists. Bundled payments are a 1-time reimbursement that encompasses all the care of a particular condition for a particular patient for a specific period. Bundled payments reimburse for episodes of care that consist of many components, including patient evaluation, laboratory testing, medications, and procedures, delivered by a diverse group of healthcare professionals often in more than 1 setting. The methods to develop bundled payments are not standardized; historical claims data are often used as the basis for modeling. Bundled payments can be based on the mean or a percentile threshold of historical claims; they can also be case adjusted, meaning the dollar amount can be adjusted depending on the characteristics and comorbidities of a particular patient. It is also important to define the episode of care duration, criteria for patient inclusion, and services included (and excluded) by the bundled payment.

Actinic keratoses (AKs)—dysplastic, keratinocytic lesions—are one of the most frequently managed conditions in dermatology practices across the United States. Between 1990 and 1999, approximately 14% of dermatology visits were related to AKs. A 2013 study found a 7% prevalence of AKs in the United States. It is estimated that more than 58 million Americans are living with AKs. Risk factors for developing AKs include male sex, older age, fair complexion, and high lifetime UV exposure. Thus, the burden of AK is expected to grow as the proportion of the US population older than 65 years increases. The direct cost of AK care in 2004 was estimated at $1.2 billion of annual US health care expenditures. Studies show that more than 50% of AK annual cost is related to procedures. Standard fee-for-service reimbursement models potentially incentivize procedures and frequent office visits. The Centers for Medicare & Medicaid Services has had concerns about rapid increases in use of the Current Procedural Terminology (CPT) codes for AK destruction procedures, and values were adjusted downward. Similarly, dialysis facilities had been reimbursed for each unit dose of erythropoiesis-stimulating agents (ESAs). This policy may have encouraged the frequent use of ESAs because the reimbursement was often higher than the cost to obtain the drug. Medicare spending on ESAs increased from $200 million to approximately $2 billion despite emerging data showing a lack of benefit. A prospective bundled payment was enacted in 2010, which covered dialysis procedures and supplies, office visits, laboratory tests, and medications. After bundled payments were introduced in 2010, there was a decline in the use of ESAs, especially among patients who were less likely to benefit.

Bundled payments are often associated with surgical procedures, such as orthopedic procedures. Bundled payments for chronic conditions, such as diabetes mellitus, asthma, and hemodialysis, have been piloted; however, there is limited research regarding the application of bundled payments for dermatologic care. The purpose of this study is to investigate several methods to develop bundled payment models for AK management and the theoretical effect of a bundled payment on the cost of AK management.

### Methods

The study was considered exempt by the Penn State Milton S. Hershey Medical Center institutional review board.

#### Description of the Study Samples

**Highmark Sample**

In this retrospective analysis, claims data were obtained from Highmark Incorporated, a large private insurer for the mid-Atlantic region, including western and central Pennsylvania regions. Individuals who were continuously enrolled and had at least 1 claim for AK (International Classification of Diseases, Ninth Revision [ICD-9] code 702.0) were eligible and their demographic, utilization, and cost information were extracted. Overall, 95,294 patients were included in the “local” sample. Paid claims for the period of January 1, 2010, to December 31, 2012, were included. To develop and validate the bundled payment models, the sample was randomly divided into 2 data sets. The test data set (n = 47,002) was used to develop 8 alternative payment models. The second, validation data set (n = 24,960), included patients with AK claims in 2010. They were chosen because of the availability of patients from 2010 in the nationally representative data set. This cohort was sequenced until the models were finalized, and was used to cross-validate the performance of the models.

**Nationally Representative Sample**

A random sample of patients with at least 1 AK-related claim in 2010 (n = 46,567) was selected from the Truven Health MarketScan Commercial Claims and Encounters Database (Truven Health Analytics). The MarketScan database contains health insurance claims that are voluntarily submitted by approximately 100 payers. Information for more than 120 million insured individuals in the United States from geographically diverse locations is included, making the database representative of the commercially insured US population. Claims for outpatient visits and prescription pharmacy use (both retail and mail order) were obtained.
Both data sets are claims databases, so clinical outcomes are not included and validation studies of the variables have not been performed.

**Definition of Cost Variables**
Costs for clinical care including office visits, AK-specific procedures, and AK-related medications were included in the development of the bundled payment. Biopsy was considered a laboratory test related to AK care so was included; pathology services were excluded because processing and effort by the pathologist is outside the clinical realm. Inpatient claims were also excluded because AKs are not treated in this setting. Costs were measured from the perspective of the health care system, which was taken as the sum of costs paid by the patient and the insurer. The annual total cost was calculated for each year that a member was enrolled. All costs were adjusted for inflation based on the medical care component of the Consumer Price Index reported by the Bureau of Labor Statistics and are reported in 2012 US dollars.\(^{15}\)

**Definition of Other Variables**
Patients with a history of nonmelanoma skin cancer (NMSC) were identified using ICD-9 codes 173, 232, and V10.83. The utilization and cost of biopsy procedures (CPT codes 11000, 11101) were included. Treatment data included the frequency of utilization and costs for destruction of AKs (CPT codes 17000, 17003, or 17004), photodynamic therapy (CPT codes 96567, J7308, J7309), or topical prescription therapy. Prescription treatments were limited to fluorouracil, imiquimod, diclofenac sodium, and ingenol mebutate and were identified by drug name and national drug code number.

**Analysis**
Cost Identification
Descriptive statistics were used to describe the age and sex of the enrollees. The utilization and cost variables included the number of claims and cost per claim for outpatient visits and prescription medications. Comparisons of the continuous outcome variables were made using a t test or analysis of variance test with a Tukey correction for groups of 3 or more. Comparisons of proportions were made using the \(\chi^2\) test with Bonferroni correction for groups of 3 or more.

**Development of the Bundled Payment Models**
Relatively simple bundled payment models were developed; factors that were not within the control of the health care institution or clinician, such as age, sex, and nonmelanoma or melanoma skin cancer comorbidities, were considered as potential factors for risk adjustment in reimbursement models. We planned a priori to develop percentile-based (50th, 75th) payments and mean-based models, with adjustments, an indirect payment, and/or a 2% discount,\(^{22}\) the latter being similar to Centers for Medicare & Medicaid Services models. Payment adjustments were based on the multivariate ordinary least squares regression model that incorporated those variables. The indirect payment was added to compensate clinicians for the time and effort put into managing patients in ways other than providing direct patient care, for example, increased effort communicating by telephone or time dedicated to teledermatology. The indirect payment was based on the direct overhead for the dermatology clinic incurred for 1 hour of patient visits for 1 physician and was fixed at $64.

**Evaluation of the Alternative Payment Models**
Several measures were used to evaluate the performance of the bundled payment models, including the difference between the actual and predicted cost, the number of patient-years with a predicted cost that was higher or lower than the observed cost, and the difference in the total cost of the cohorts for the payer.

Sensitivity analyses were performed to determine how the performance of the models would change if costs such as the mean or adjusted mean (sex based or NMSC based) were higher or lower. Each payment was allowed to vary from the upper to the lower 95% confidence limit of the mean. A sensitivity analysis was also performed to investigate cost difference changes related to the proportion of people with a history of NMSC or male sex.\(^{13,23,24}\) SAS, version 9.3 (SAS Institute, Inc), was used for all analyses. All statistical tests were 2 sided and \(P < .05\) was considered statistically significant.

**Results**

**AK Utilization and Cost Identification**
Table 1 shows the characteristics of the 3 study samples. The entire Highmark or “regional” sample (\(n = 95294\)) had more than 400 000 claims for AK, of which 89.1% (383 030 of 430 050) were associated with a dermatologist. Most patients (79.8% [\(n = 76 045\)]) received care from only 1 physician. Male sex, increased age, and history of NMSC were associated with higher mean 1-year cost per patient (Table 2).

The total cost of AK-related care for the 3-year period, composed of prescription and outpatient claims (visits and procedures), was $40 719 495. During the 3-year period, there were an estimated 103 727 outpatient office visits for AK, and the most common visit frequency for patients was annual (67.1%). Destructive procedures (CPT 17000, 17003, and 17004) accounted for $18 277 451 (44.9%) of the 3-year total outpatient cost. Of this, $12 643 105 (69.2%) arose from claims for destruction of 1 AK (17000); $3 441 325 (18.8%) for destruction of additional AKs, up to 14 (17003); and $2 193 021 (12.0%) for destruction of 15 or more AKs (17004).

The mean annual costs for claims related to office visits and procedures are shown in Table 3. The mean (SD) cost for appointments with a destructive procedure for 1 AK (17000) was $128 ($113) and $263 ($167) for “extensive destruction” of 15 or more AKs (17004). The mean (SD) cost for the destructive procedure alone was $82 (38) for 1 AK (17000) and $209 ($74) for “extensive destruction” of 15 or more AKs (17004).

There were 8098 prescriptions filled by 6.0% (5756) of the patients, which accounted for $3 489 263 (8.6%) of the total 3-year cost. Patients also underwent other outpatient procedures, such as biopsies and photodynamic therapy (PDT), associated with AK management. The total 3-year cost for
PDT was $372,761 (0.9%). The 3-year cost for biopsy procedures was $691,228 with a mean (SD) cost of $99 ($75) per procedure.

Performance of the Theoretical Bundled Payment Models

Eight bundled payment models, all based on 1 year of care, were developed: 2 based on the sample’s 75th percentile payment ($306), 3 based on median payment ($173), and 2 based on mean payment ($262 [unadjusted] or $209 [adjusted]). Three of the models included payment adjustments for male sex ($51) and history of NMSC ($234). Age adjustment was not included because the difference among the groups older than 50 years was minimal (Table 2). The 8 models were applied to the 2 validation data sets to assess the performance of the models in other patient groups.

Two of the 8 models, those based on the 75th percentile payment, did not result in theoretical savings for any of the 3 patient samples from the perspective of the health care system (Figure 1 and eTable 1 in the Supplement). The median-based payment without adjustments resulted in the largest theoretical savings. In contrast, the mean-based payment with adjustments for history of NMSC and sex resulted in the smallest theoretical savings. Of note, the mean-based payment resulted in small savings for 2 samples, but resulted in a theoretical increase in cost when applied to the national sample.

We also investigated the proportion of patients with an actual annual cost less than or equal to the theoretical bundled payment—or care that would be “covered” by the alternative payment model. The bundled payment that covered the largest proportion of patients in all 3 samples was the 75th percentile–based payment with an adjustment for sex and history of NMSC (eTable 2 in the Supplement). The payment that covered the smallest proportion of patients was the median-based payment. The bundled payments with the largest discrepancies between the test and national sample were the mean-based payment (49.6% vs 48.2%; P < .001) and the sex- and NMSC-adjusted median-based payment (66.9% vs 69.7%; P = .02). The median-based payment with an indirect payment covered similar proportions of patients in the 3 samples. Figure 2 shows the proportion of patients in the national sample whose cost of annual care was lower than or equal to the bundled payment.

Similarly, we grouped patients according to clinician, then for each clinician summed the cost of actual care from claims and compared this to the theoretical bundled payment models (eTable 3 in the Supplement). Figure 2 shows the
Discussion

Bundled payments are a leading alternative payment model, yet methods to develop bundled payments have not been firmly established. Our study shows that bundled payments have the potential to decrease cost with modest savings for the adjusted mean-based models or larger savings with unadjusted median-based models. Since 2015, MACRA has encouraged alternative payment model implementation, especially among expansion specialists. Specialists’ representatives can submit proposals for alternative payment models to a Technical Advisory Committee for consideration.2 This is a valuable opportunity for specialists to actively participate in reforms by developing and submitting possible alternative payment models.

Importantly, some models, those based on the 75th percentile, projected an increased cost for AK care. None of the bundled payment models in this study covered the actual costs of every patient or every clinician, but the purpose of the bundled payment is to approximate the current payment, but “bend the cost curve” by controlling outliers and putting in place incentives for coordinated, evidence-based care.25 The median-based model with indirect payment and mean-based adjusted models (with and without 2% discount) covered similar proportions of patients’ costs, meaning the theoretical bundled payment was equal to or exceeded the actual AK-related costs. Also, a similar proportion of clinicians had payments by these models that were equal to or greater than the actual claims income. We adjusted payment for male sex and a history of NMSC because these have been associated with a higher burden of AK.10 Studies show that clinicians prefer payment adjustments for patient comorbidities that add to management complexity.14,20 For example, with the adjusted mean-based payment model, the health care system would be paid

Table 2. Mean Annual Cost for Actinic Keratosis Management per Patient in the Entire Highmark (Regional) Sample Stratified by Age Group, History of Nonmelanoma Skin Cancer (NMSC), and Sex

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Annual Cost Per Patient, $</th>
<th>Mean (SD)</th>
<th>Median</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>248 (292)</td>
<td>173</td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male</td>
<td>307 (374)</td>
<td>202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>177 (181)</td>
<td>113</td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>30-39</td>
<td>224 (282)</td>
<td>154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>248 (298)</td>
<td>173</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>276 (341)</td>
<td>186</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>292 (383)</td>
<td>191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>281 (310)</td>
<td>189</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥80</td>
<td>289 (330)</td>
<td>191</td>
<td></td>
<td></td>
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<tr>
<td>Diagnosis of NMSC**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>244 (266)</td>
<td>176</td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Yes</td>
<td>445 (534)</td>
<td>291</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Comparison based on mean values.

**Defined as NMSC prior to or during study period.

proportion of clinicians in the national sample for whom the actual cost for his/her AK patient cohort was less than or equal to the theoretical bundled payments for the cohort. The 75th percentile with sex- and NMSC-based payment model had the highest proportion of clinicians with costs at or below the amount allowed by the model; however, this model had a theoretical higher cost. Similarly, the mean-based payment model had the second-highest proportion of clinicians with actual health care cost less than or equal to the bundled payments; however, this model had a theoretical savings for the regional samples but a theoretical increase in cost for the national sample. The median-based payment model had the fewest clinicians with patient costs lower than or equal to the bundled payments. The median-based payment model also had the largest difference between the test and national samples (38.6% vs 48.3%; P = .002).

Sensitivity analyses of payment amount for sex and history of NMSC showed a potential increase of 0.3% to 2.2% or a decrease of 0.2% to 1.4% in total cost depending on the payment model. Similarly, if the proportion of men, and related patient-years, was increased to 60%, then the total cost could increase 0.9% to 1.5% depending on the model. Also, if the proportion of patients with any history of NMSC was increased to 15%, the cost could increase 1.6% to 2.5%.
$494 or $443 for the care of a male or female patient, respectively, with a history of NMSC for 1 year. Similarly, the payment for AK-related care for a male or female patient without a history of NMSC would be $260 or $209, respectively. These payments may encourage clinicians to consider the costs of AK care differently: the cost of topical therapies as something greater than the patient’s medication co-pay; the cost variation among topical medications; the balance of cost and effectiveness for AK therapies, namely, cryotherapy vs photodynamic therapy vs various topical therapies.
Changes in health care payment also need to be appropriately balanced with monitoring of patient and disease outcomes to ensure that high-quality care is provided. Bundled payments have been implemented for chronic conditions, including diabetes mellitus and end-stage renal disease. Long-term data on disease and patient outcomes are not available with studies of bundled payments for end-stage kidney disease and diabetes care; however, multiple studies show improved process measures such as care coordination, patient satisfaction, efficiency of care, improved record keeping, and protocol adherence. Prior studies showed that bundled payments encouraged better definition of the roles of each clinician and improved communication among clinicians and payers. Collaboration also improved so redundancy decreased, knowledge of costs improved, and patient care was more effective. Prior work has shown that clinicians can find ways to decrease health care cost if they are educated about the cost of services, such as laboratory or radiologic tests. Bundled payment also encouraged clinicians to give more guideline-consistent care, which may ultimately improve health outcomes.

Several limitations of the study deserve comment. The claims data lack detailed information characterizing all aspects of the disease and assumptions are made about the accuracy of the diagnostic codes on the claims. The data sets may also have limitations due to the geographic location and demographic composition of the enrollee group, including an underrepresentation of patients 65 years and older. Claims were selected on the basis of the ICD-9 code for AK; there may be errors in the data due to coding variability. The application of a bundled payment in an outpatient health care setting is complex, and this study did not investigate application in the clinical setting. Coordination of care and cost assignment across clinicians are challenges to real-world implementation. Further work is needed to implement an alternative reimbursement system. The period analyzed in our models may need to be longer than 1 year because this may influence the decision of patients and clinicians to use PDT or topical medications, which may have a higher 1-time cost than cryotherapy but may have clinical effects outside the payment period.

Conclusions

As health care systems and clinicians move toward population health models of care, it is important to consider alternative payment models, such as bundled payments. These payment models can use economic principles to shift practice from quantity to consideration of population health, evidence-based management, and patient-centered measures of quality and cost. Bundled payment models are complex, and implementation includes the development of the payment amount, as well as establishing measures of patient outcomes, defining the services included and excluded from the bundle, and defining the payment accountability (tracking who delivers care and how it is shared among clinicians and other staff). Dermatology as a field needs to prepare for payment reform by understanding disease management in dollar terms. This will enable the specialty to advocate on behalf of clinicians and patients for fair and reasonable reimbursement, regardless of the type of payment.

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REFERENCES