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BUNDLED PAYMENT MODELS FOR ACTINIC KERATOSIS

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ABSTRACT

Importance: Actinic keratosis (AK) is a skin condition induced by ultraviolet light and has the potential to progress into skin cancer. AK affects approximately 7% of the United States (US) population. In 2004 the US health care spending for AK management was $1.2 billion. Some of the procedural treatments for AK were targeted by CMS for reduced reimbursement, potentially due to over-utilization. Alternative reimbursement models are being investigated in other therapeutic areas to reduce costs, but there is little investigation for dermatologic conditions.

Objectives: To assess AK-specific healthcare utilization and costs and develop eight bundled payment models.

Methods: A retrospective cohort was obtained from a large private insurer for the mid-Atlantic region (January 2010 to December 2012). This sample was used to describe utilization and cost, and served as a test and a validation sample for bundled payment development. A random sample from a nationally representative dataset, the Truven Health MarketScan® database, was used as a second validation sample.

Results: The total cost of AK-related care was $40,719,495 for 95,294 patients with AK. Of this cost, prescriptions accounted for 8.6% and outpatient care for 91.4%, of which 44.9% was due to destructive procedures. The use of extensive destruction (CPT 17004), prescription medication therapy, male gender and age were associated with a higher mean three-year cost, although the cost data were right-skewed and had a large variance. Winsorization was applied at the $1^{st}/99^{th}$ and $5^{th}/95^{th}$ percentiles, which reduced the mean 3-year cost by $34 and $64, respectively. Several percentile- and mean-based bundled payments were developed, with and without adjustments, and most predicted savings over historical reimbursements. All of the models predicted that some patients and providers would have costs above the bundled payment.

Conclusions and Relevance: Bundled payments appear theoretically feasible for AK management, but further work is needed to determine the method that is most equitable for providers and patients. Gender and history of non-melanoma skin cancer (NMSC) were used to adjust payments as these contributed importantly to variation in cost. More research is needed to establish the value of various treatment methods in order to guide practitioners’ and patients’ decisions. In addition, the utility of bundled payments for AK management needs to be implemented and compared to other reimbursement models.

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LIST OF ABBREVIATIONS

AK: actinic keratosis
CI: confidence interval (95%)
CPT: current procedural terminology
ICD-9: international classification of diseases, 9th revision
NMSC: non-melanoma skin cancer
OR: odds ratio
SCC: squamous cell carcinoma
SD: standard deviation

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Chapter 1 Introduction

1.1 Impact of actinic keratosis management

Actinic keratoses (AK) are one of the most commonly managed conditions by dermatologists. The combination of a high prevalence among some subgroups of the US population and preferential use of destructive therapies can lead to a significant societal health care burden.[1-4] In 2006, the estimated annual US health care spending for AK management was $920 million dollars.[2,4] AKs are especially common among adults ages 60 to 69, with 83% of men and 64% of women having at least one AK, and this subset of the population is growing. Data from the US census suggested a disproportionate increase in the proportion of men with AK in the US population from 2000 to 2010. Similarly, the 45 to 64 year old age group grew by 31.5% and the 65 years or older group grew by 15.1%, which was a larger increase than other age groups.[5] These population changes, with an expanding, at-risk age group of Americans more older Americans and more men, suggest that the utilization and spending for AK management needs to be updated and the reimbursement methods questioned in order to sustain adequate care and responsible healthcare cost stewardship.

1.2 Actinic keratosis biology

AK are dysplastic keratinocytic skin lesions that are induced by ultraviolet (UV) light. The prevalence varies from 1.5% to 50%, depending on the population studied.[3,6] In addition to UV-exposure, older age, fair complexion and male gender are also risk factors for AK.[3] The prevalence of AK for men 65-74 years old was estimated at 55.4% compared to an overall population prevalence of 7%.[7,8] AK are found predominantly on chronically UV-exposed body sites, such as the scalp, face, ears, and hands.[1,6] The exact risk of malignant transformation from an AK into a SCC is controversial. Studies have shown that AK can have p53 mutations, which are found in about 90% of squamous cell carcinoma (SCC).[9-11] However, the prevalence of p53 mutations in AK is lower (7-11%).[12,13] This may be one reason that clinical studies show low rates of malignant transformation of AK to SCC and some chance of spontaneous remission.[6,14,15] Marks et al. prospectively studied a group of over 1,000 people with AK for 12 months and showed that 25.9% of AK present at the baseline examination had spontaneously resolved.[15] A second study by Marks at al. observed 1,689 people with 21,905 AK over two years and detected 28 SCC in 26 patients.[14] The authors concluded that the risk of AK transformation was 0.075% per year. In another study, the majority of AK detected at baseline had resolved after 12 months and including 29% of the AK that developed during the study.[8] There is limited evidence to show that widespread eradication of AK for a patient will reduce the likelihood of developing SCC.[16,17] The limited or contradictory evidence is difficult for patients and providers to resolve and leads to a large variability in management practice, which ranges from observation to eradication depending on interpretation of the evidence.

1.3 Recent AK Management and Changes in Health Care

In 2004, the estimated US health care spending for AK management was $1.2 billion, of which 7.1% was attributed to prescription drugs and 91% arose from outpatient treatment.[2] In 2006, Warino et al. showed a similar annual cost of $920 million, with only 5% of patients receiving a prescription for a topical medication.[4] Cryotherapy is a common method to destroy AK, which is utilized approximately 3 million times per year to treat AK and accounts for about half the total AK cost.[4] Recent regulations reduced the reimbursement of multiple AK-specific destruction codes (CPT 17000, 17003, 17004) by 10 to 13%.[18] This may have been prompted by the frequent use and significant cost associated with these codes. These studies were not able to investigate whether patient factors (such as age in years, gender, and comorbid skin diseases) or provider characteristics were associated with utilization or spending. The 2004 cost-identification study used data from the National Health and Nutrition Survey in 1974.[2] The 2006 study utilized data from the National Ambulatory Medical Care Survey, which collects information through interviews from non-federally employed office-based physicians about their practice for a one week period.[4]

Changes in health care are visible and as population-based models of health care become more common, it is increasingly important to understand how a disease is treated and the cost of care. Few studies have investigated the variability of AK management in populations. Variability is an important issue for health care for several reasons, including the potential to decrease health care spending by decreasing sources of variability that do not add value to patient outcomes.[19-21] For example, geographic variation in spending, not explained by aspects of the disease or patients, may present an opportunity to decrease waste or recoup excess spending.[22,23] In dermatology, studies of non-melanoma skin cancer (NMSC) have demonstrated local differences in the utilization of treatment procedures, which were not explained by patient or tumor characteristics.[24,25] The traditional fee-for-service (FFS) payment model is often cited as a contributor to the high cost and variability of US health care. In this model multiple clinicians are paid separately for each instance of service, which incentivizes the quantity of services, rather than care quality, coordination, or collaboration.[26,27]

1.4 Bundled Payment: An Alternative Reimbursement Model for AK

Alternative reimbursement methods, such as the bundled payment model, have been advocated so that clinicians have a financial incentive to decrease waste. A bundled payment model provides a payment "bundle" for *all* of the care a patient needs for a specific clinical condition for a discrete period of time. In contrast, the traditional FFS payment favors high frequency of service and the use of procedures. Shifts away from FFS are important to consider in dermatology as cryotherapy is the most common procedure performed and has already had the reimbursement payment decreased.[2] In addition, there are numerous methods to treat AK and practice variability has become a source of interest in order to decrease waste. Prior studies have shown that there is variation in AK management and cost.[20,28,29] One method to reduce health care cost is to increase the use of services that reliably deliver high quality patient outcomes with less waste and decrease the use of services with higher cost or lower quality outcomes.[30,31]

Bundled payment is often associated with capitation, however there are some important distinctions. Capitation payments are risk- and case-adjusted payments made in advance to a clinician for the delivery of *all health care services* for a population *whether or not a patient utilizes care*.[32] In contrast, bundled payments occur only when a patient has a condition and obtains care. Changes in payment should be accompanied by measures to ensure that the quality of care is maintained or improved. For example, quality measures should assess patients' access to care, management quality and whether sicker or higher-cost patients are equally and fairly treated.[33]

The rationale for bundled payments is strong, but there is limited evidence on the practical development of a bundled payment and the outcomes of implementation.[34,35] The Affordable Care Act encourages bundled payment models and pilot programs have been administered through the Centers for Medicare and Medicaid Services (CMS).[26] There is no single method or “best practice” that has been established for developing a bundled payment. Some payment models are median or percentile-based[34] and other models are based on the mean.[36] Still another variation on bundled payment models is to incorporate payment adjustments based on factors associated with higher needs and costs.[36] Another aspect to consider is a fee for indirect costs such as overhead, staffing, and other support services that would no longer be subsidized by reimbursement from clinical services. Cutler and Ghosh modeled the effects of theoretical bundled payments for conditions with the highest costs for patients 65 years and older. The actual total spending in 2007 was $64.8 billion for osteoarthritis, heart disease, hip fracture, stroke, and pneumonia. The theoretical bundled payment was estimated to reduce previous spending by $10 to $35 billion.[34] However, this analysis did not include any adjustments to the payments or the perspective of providers. PROMETHEUS developed a bundled payment based on historical service use and costs patterns, including potentially avoidable complications.[37] This method is frequently utilized for acute bundles, such as those utilized for surgical procedures.

Given all of the various methods and potential adjustments to develop a bundled payment, there is a need to investigate these methods if bundled payments for AK are being considered. The first aim of this study is to update the literature on AK-related healthcare utilization and spending, including differences associated with age and gender. This study differs from prior work because it will utilize a regional dataset that includes health insurance claims rather than recalled performance, and continuous rather than intermittent reporting. The second aim of this study is to investigate the variability of cost for AK management and the theoretical savings if extremes of cost were curtailed. The final aim is to develop several bundled payment models for AK management and to investigate the theoretical impact on the cost to providers and patients. A patient-level episode was selected as this removes the incentive to repeatedly care for the same issue on the same person.

Chapter 2 Methods

2.1 Description of the Study Samples

2.1.1 Highmark Sample

In this retrospective analysis, claims data were obtained from Highmark Incorporated, a large private insurer for the mid-Atlantic region, and included data for enrollees in the western and central Pennsylvania region. Paid claims for the period of January 2010 to December 2012 were included, as well as three months beyond December 2012 to avoid exclusion of delayed claims.[38] Individuals that were continuously enrolled and had at least one claim for AK (ICD-9 702.0 or 702.1) were eligible and their demographic, utilization and cost information were extracted. Overall, 95,294 patients were included in the local sample.

This sample was randomly divided into two datasets. One was designated the ‘test’ dataset and was used to develop several alternative payment models. The second dataset was designated the ‘validation’ dataset and was sequestered until the models were finalized. Patients in the validation dataset with AK claims in 2010 were used to cross-validate the performance of the models.[39,40]

2.1.2 Nationally-representative Sample

Additionally, a random sample of patients with at least one AK-related claim in 2010 was selected from the Truven Health MarketScan® Commercial Claims and Encounters Database (Truven Health Analytics) was identified. The MarketScan® database contains health insurance claims that are voluntarily submitted by approximately 100 payers. Information for over 120 million insured individuals in the US from geographically diverse locations is included, making the database representative of the commercially insured population in the US. The database contains information pertaining to inpatient hospital stays, outpatient visits, and specialty pharmacy use (both retail and mail order). Because it is a claims database, clinical outcomes are not included and validation studies of the variables have not been performed. The sample was selected with an approximately 1:1 ratio to the test dataset and was also used to evaluate the performance of the bundled models.

2.2 Definition of Cost Variables

Costs for office visits, biopsies, and procedure and treatment costs were included and inpatient claims were excluded because AK are rarely treated in this setting. Costs were measured from the perspective of the healthcare system and included 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.[18]

2.3 Definition of Other Variables

Patients with a history of non-melanoma skin cancer (NMSC) were identified using ICD-9 codes 173, 232, and V10.83. Treatment data included the frequency of utilization and costs for destruction of AK (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, and ingenol and were identified by drug name and national drug code number. Biopsy procedures (11100, 11101) and the associated pathology services (8830X [-2,-4,-5,-7,-9], 88342, 88312) were also included.

2.4 Analysis

2.4.1 Cost-identification

Descriptive statistics were used to describe the age and gender of the enrollees. The utilization and cost variables included the number of claims and cost per claim for outpatient visits and prescription medication claims. Descriptive statistics were performed for several variables including age, gender, utilization and cost. Comparisons of the continuous outcome variables were made using a *t* test or ANOVA test with a Tukey correction for groups of three or more. Comparisons of proportions were made using the Chi-square test and the Bonferroni correction was used for three or more comparisons.

2.4.2 Variability and Extremes of Cost

Cost data are often highly skewed, with very high costs generated by a small number of individuals.[38,39] Winsorization was used to diminish the effect of outliers; this method can maintain the direction of outliers but decreases the magnitude of the effect on the mean and standard deviation.[41] Winsorized analyses utilized the complete dataset and transformed the values above and below the designated percentiles. In large datasets, parametric tests of the mean can be robust so ordinary least squares (OLS) was used to perform multivariate analyses to examine the association between cost and several patient and management-related factors.[14-16] Multivariate logistic regression was performed to identify associations between these variables and whether the patient's three-year costs were in the top 5th percentile or in the lower 95^{th} percentile.

2.4.3 Development of the Bundled Payment Models

Relatively simple bundled payment models were developed so that time and money would not be wasted on documentation of multiple variables or patient characteristics that would determine payment. Factors that were not within the control of the provider, such as age, gender, and comorbid conditions were considered as potential factors for risk adjustment in reimbursement models. Percentile-based payments and unadjusted mean-based models were developed using descriptive statistics of the test population. Mean-based models *with* adjustments were based on the intercept of the multivariate OLS model that incorporated the variables for which payment adjustment would be made.

2.4.4 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 population's total cost for the payer. A sensitivity analysis was performed on the mean-based models in order to determine how the performance of the model would change if the mean was higher or lower. The unadjusted mean payment was allowed to vary from the upper to the lower 95% confidence limit of the mean. Similarly, the adjusted mean payment, which was the basis for other adjustments was allowed to vary from the upper to the lower 95% confidence limit of the mean, without modifications to the gender- or NMSC-based payment adjustments. The gender- and NMSC-based payments adjustments were also allowed to vary from the upper to the lower 95% confidence limit of the mean. A sensitivity analysis was also performed to investigate changes in the cost of the models if the proportion of people with a history of NMSC or male gender were varied in accordance with prior studies.[2,42,43] The 95% confidence limits were obtained with a bootstrapping analysis that utilized sampling of 500 patients for 1,000 repetitions. Stata 13 (StataCorp LP, College Station, TX) was used for multivariate analyses and bootstrapping. SAS 9.3 (SAS Institute, Inc., Cary, NC) was used for all other analyses. All statistical tests were two-sided and a *p*-value less than .05 was considered statistically significant. The study was considered exempt by the Penn State Hershey Medical Center Institutional Review Board.

Chapter 3 Results

3.1 AK Utilization and Cost-Identification for the Local Sample

The Highmark sample included a total of 95,294 individuals who were continuously enrolled for the three-year period (January 2010 to December 2012) and had at least one claim for AK. There were over 400,000 claims for the study population and 89.1% (383,030/430,050) of these were associated with a dermatologist. The characteristics of this group are presented in Table 1. The mean (± standard deviation [SD]) age for the sample was 66.5 ± 12 years. The mean age (SD) for men was slightly higher than for women (68 ± 11 vs. 65 ± 13; p<0.0001). NMSC was diagnosed, during or prior to the study period, in 13,849 (14.5%) patients.

During the three-year period, there were an estimated 103,727 outpatient office visits that included a diagnosis of AK and 8,098 prescriptions for AK-related topical therapies. Most of the patients (79.8%, n=76,045) received care from one physician and 84.1% (n=79,974) received all of their care in the same 3-digit zip code. The total cost of AK-related care for the three-year period, comprised of prescription and outpatient claims (visits and procedures), was $40,719,495. The total cost of AK treatment per study year was $12,706,898 in 2010, $14,105,580 in 2011, and $13,907,016 in 2012. Outpatient visits accounted for $37,230,232 (91.4%) of the total three-year cost. Annual visits were the most common frequency and accounted for 67.1% of all visit frequencies. The next most common visit frequency was twice annual visits, which accounted for 23.2% of all visit frequencies.

Most (59.6%) patients that had a destructive procedure for AK also had a claim for an evaluation and management service (Table 2). Destructive procedures [codes 17000, 17003, and 17004] accounted for 44.9% or $18,277,451 of the three-year total outpatient cost. Of this, $12,643,105 (69.2%) arose from claims for destruction of one AK (17000), $3,441,325 (18.8%) for destruction of additional AK, up to 14 (17003), and $2,193,021 (12.0%) for extensive destruction (17004). The three-year mean (SD; CI) total outpatient cost for those that required extensive destruction (17004) once or more in the three-year study period was $948 (1,025; 912-984), compared to $431 (577; 428-435) for those that never had a claim for 17004 (p<0.0001). Individuals treated with extensive destruction (17004) were also older than those who never had this treatment (69 ± 11 vs. 65 ± 12, p<0.0001) and more likely to be male (68.9% vs. 53.3%, p<0.0001). Table 3 shows the costs stratified by gender and age group; both older age and male gender were associated with higher mean one-year and three-year cost per patient.

Prescription claims for AK-related medications accounted for $3,489,263 (8.6%) of the total three-year cost and were used by 6% (5,756) of the patients. The most frequently prescribed medication was fluorouracil.

The mean, SD and median annual costs per person were $281.78 ± 342.80 and $187.62, respectively. In comparison, the mean, SD, and median three-year costs per person were $447.74 ± 604.28 and $258.49. Based on the size of the SD, the effect of the outliers was examined. The first, fifth, ninety-fifth and ninety-ninth percentiles for total three-year cost per patient were approximately $42, $72, $1,355, and $2,622, respectively.

3.2 Variability and Extremes of Cost

After Winsorization at the first and ninety-ninth percentiles, the mean (SD; CI) three-year total cost per patient was shifted from $448 (604; 445-453) to $413 (457; 411-416) (p<0.0001). After Winsorization at the fifth and ninety-fifth percentiles, the mean (SD) three-year total cost per patient was $384 (348; 382-386) (p<0.0001). If the annual cost per patient was capped at the 99th percentile for each year, the cost savings for 2010, 2011, and 2012 would have been

$406,826, $421,852, and $391,819, respectively. Similarly, if the annual cost per patient was capped at the 95th percentile, the cost savings for 2010, 2011, and 2012 would have been $1,256,364, $1,324,909, and $1,289,057, respectively.

A logistic regression was performed to investigate the factors associated with being a high-cost patient, defined for this purpose as members with three-year costs in the top 5th percentile (Table 4). This analysis demonstrated that multiple factors were associated with higher odds of being in the top five percent of three-year cost. For each extensive destruction procedure the odds (95% CI) of the patient being in the top fifth percentile of three-year cost more than tripled (OR=3.20; 95% CI: 3.00-3.41). Similarly, the odds of being in the top 5% of costs over three years were more than double (OR=2.20; 95% CI: 2.08-2.32) with each claim indicating NMSC, and increased more than eight times (OR=8.18; 95% CI: 7.28-9.19) for each prescription for topical AK therapy.

3.3 Performance of the Theoretical Bundled Payment Models

Table 5 shows the characteristics of the three samples. The "national" validation sample was younger on average than the other samples and had fewer patients with a history of NMSC. The Highmark validation sample had a higher proportion of men. Comparing costs, the national validation sample had a smaller proportion of cost due to prescription medications for AK, lower mean but higher median cost per patient.

Eight bundled payment models were developed based on the test sample; two based on the 75th percentile payment ($306), three based on the median payment ($173), and two based on the mean payment ($262). This corresponded to the 69.0th percentile of the annual payment for the test sample. Three of the models included payment adjustments for male gender ($51) and history of NMSC ($234). Sensitivity analyses demonstrated that if the payment for the unadjusted mean model was varied to the upper and lower 95% confidence limit of the mean then the total cost of the model would increase by 1.1% or decrease by 0.7%. This was repeated for the adjusted mean-based model; changes in the mean base resulted in an increase by 1.1% or decrease by 1.4%. For the mean-based model if the values of the gender and NMSC-history adjustments were varied then the cost increased or decreased by 0.9% and 0.5%, respectively. In median and 75th percentile models, if the gender-based adjustment was varied then the cost would vary by 2.2% or 1.4%, respectively. If the NMSC-based adjustment was varied then the cost would vary by 0.3% or 0.2%, respectively.

The proportion of men was 53.9% and accounted for 57.0% of the patient-years. If the proportion of men in the study population was increased to 60%, and the ratio of patient-years was preserved, then the change in cost for an increase to 45,740 patient-years and gender-adjusted models would have an increase of $236,588 or 0.9-1.5% depending on the model. Similarly, if the proportion of people with any history of NMSC was increased to 15%[42] and the ratio of patient-years was maintained then the risk-adjusted model for 9,178 patient-years would increase the total cost of NMSC-adjusted models by $407,747 or 1.6-2.5%.

Table 6 shows the potential savings and over-runs as differences and proportions of the actual cost for each of the eight theoretical bundled payments. The aim of a bundled payment model is not to perfectly forecast future costs based on current cost and utilization, but to "bend the curve", and to purposefully decrease cost. Two of the eight models, those based on the 75th percentile payment, did not result in theoretical savings for any of the three samples. 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 gender resulted in the smallest theoretical savings. Of note, the mean-based payment resulted in small savings for the two samples derived from the Highmark dataset but this bundled payment model resulted in a theoretical over-run when applied to the national sample.

The theoretical bundled payment models were applied to all three samples to assess how much of the population already had an annual cost that was less than or equal to the theoretical payment. Table 7 shows the proportion of each sample that had an annual cost less than or equal to the bundled payment for AK. The bundled payment that covered the largest proportion of patients was the 75th percentile-based payment with an adjustment for gender and history of NMSC. The payment that covered the smallest proportion of patients was the median-based payment. Although there were statistically significant differences in the proportion of patients with costs that would be covered (actual cost was less than or equal to the theoretical payment), the absolute differences were not large. 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 gender and NMSC-adjusted median-based payment (66.9 vs. 69.7; $p=.02$). The bundled payment with the most consistency across the three samples was the median-based payment with an adjustment for indirect services. It is important to recall that the aim of a bundled payment model is not to perfectly forecast future costs based on current cost and utilization, but to "bend the curve" by purposefully decreasing cost by removing the incentive for clinicians to over-provide care.

Bundled payments encourage providers to be more cognizant of the cost of care. Providers care for groups of patients with AK and due to variability in the severity of disease and other factors the cost of care will vary. Table 8 shows the proportion of providers for whom the cost for their cohort of AK patients was less than or equal to the amount allowed by the theoretical bundled payment. In other words, the annual cost per patient was summed across all the patients for a given provider based on the actual annual cost and the theoretical bundled payments. The coverage of providers was similar to the coverage for patient-years; the model based on the 75th percentile with gender- and NMSC-based payment had the highest proportion of providers that were covered by any of the payment models. The median-based payment model had the lowest proportion of providers with costs lower than or equal to the bundled payment. The median-based payment model also had the largest difference between the test and national samples (38.6 v 48.3; $p=.002$).

Chapter 4 Discussion

Economic studies valuable because they describe the effects of disease management in dollar terms, the terms often used by policy makers but not frequently considered by clinicians. These cost estimates may assist clinicians and policy makers when they are considering the magnitude of a disease, to justify management programs, and as a first step for future economic investigations.[39] Prior cost-identification studies for AK were performed in 2004 and 2006 and the estimated US health care spending for AK management was $900 million and $920 million, respectively.[2,4] In both reports, the large majority of the total direct cost was spent on outpatient care and of this about half was attributed to either destruction of AK or outpatient visits.[4] While the current study cannot estimate the national cost for AK management, it does demonstrate that in the time since the datasets were established (decades in some cases) the utilization of destructive procedures has remained stable at about 45% ($18.3 million) of the total cost of AK management. The procedural destruction codes (17000, 17003, 17004) have had reimbursement decreased by 10% to 13% in recent years.[18]

This study echoed the findings of the prior cost-identification studies in that a small proportion of the patients (about 6%) utilized a topical medication during the three-year study period. Although individually the medications can be expensive, upwards of $800 for a treatment course, these medications comprise only a small proportion of the total cost of AK management because of the limited use by patients and/or providers. Several cost-effectiveness studies have been performed to investigate various AK treatments; however, the lack of comparative effectiveness data, information on newer medications, comparisons among all of the options, and data on long-term outcomes limit the utility of these studies to providers and patients.[4,44-46]

One prior cost-identification study compared costs for patients above and below 65 years; however, the impact of other patient- and disease-related factors on AK utilization and cost has not well described.[4] The current study was able to describe utilization and cost for several factors and showed that both men and patients with a history of NMSC have significantly higher three-year costs, from the perspective of the healthcare system (Tables 4 and 5) than their counterparts. The extra cost above the mean that was associated with male gender was about $56 and for a history of NMSC was about $234.

There has been increasing interest in curbing the trend of increasing health care costs. Health care costs are often highly skewed, such that a small percentage of the population accounts for a disproportionate amount of the costs. In this study, the mean (SD) and median for the three-year cost were $447.74 (604.28) and $258.49, respectively. The right-shift of the mean above the median and the size of the standard deviation in comparison to the mean indicate both substantial cost variability and a sufficient number of people with above average costs to shift the mean above the median. This study utilized Winsorization to explore how the overall cost would change if the influence of high-cost outliers were diminished. After Winsorizing at the 1st and 99th percentile, the mean three-year cost per patient was decreased by about $14. Although this is not a large cost when considered singly, the overall savings could be substantial in the entire population. The mean is lowered further, by about $44, when the groups below the 5th and above 95th percentiles are Winsorized. Thus, the benefits of restraining costs at the upper end of the sample more than compensated for increasing the cost of patients at the lower end of the distribution. In the model, a cap was applied at the 99th and 95th percentiles for annual costs per patient with a total savings of approximately $407,000 and $1.3 million, respectively. This analysis is meant to demonstrate the effect of diminishing the most extreme instances and provide a nidus for providers to reflect on the goals of AK therapy, the effectiveness, efficiency and value of various management options, and as a reason to encourage additional outcomes- and value-based research of spending and not to suggest a literal spending limit. As an aside, the Affordable Care Act made lifetime and annual coverage limits illegal starting in 2014.[47] Bundled payments are not affected by this legislation since the limit is placed on the provider, although it may have indirect ramifications for patients due to changes in provider behavior.

There has been more investigation into the sources of variability in healthcare costs, especially provider and geographic sources of variation, which may not add value.[19-21] This study did not aim to investigate geographical variation, in part because the Highmark sample was geographically restricted to western and central Pennsylvania. Other reports have demonstrated geographical differences in the utilization of procedures to treat NMSC, which were not explained by patient or tumor characteristics.[24,25] The patients with three-year costs in the top 5th percentile were examined and found to have higher odds of having received a diagnosis of NMSC, extensive destruction, or a prescription medication. A provider has little control over whether a patient has a prior history of NMSC, but does determine the use of extensive destruction (17004) and prescription medications. Prior studies have shown treatment variation for AK.[28,29] Some regional variation is unavoidable, due to differences in patient age, gender, health conditions, and costs of real estate and supplies.[20] The aim is to reduce health care cost by consistently using services that reliably deliver high quality patient outcomes with less waste.[30,31] Multiple studies outside of dermatology have demonstrated that educating providers about the cost of services, such as laboratory or radiologic tests, can result in a decrease in utilization and cost.[16,17,48,49] More studies are needed that investigate the effects on the provider healthcare delivery when there is education about dermatologic service costs.

Another method to address spending and cost is to change the economic incentives. Evidence has shown that physician behavior is consistent with economic theory, which predicts profit-maximizing behaviors and responses to financial incentives. For example, physicians have been shown to spend less time with patients in an HMO than patients without capitation and to schedule fewer appointments when salaried than physicians with fee-for-service (FFS) payments.[50,51] In the FFS model there is an incentive to provide more services, especially those services with higher reimbursements. One alternative to the FFS model is the bundled payment model, which has been applied to address high-cost care in the inpatient venue. All four of the bundled payment models outlined by CMS are aimed at inpatient services. The bundled payment model is one of the leading alternative payment models so it is likely that it will expand to outpatient services. However, the methods to develop bundled payments have not been firmly established. This study investigated percentile-based and mean-based bundled payments, with and without adjustment for gender or NMSC. Although the local validation sample had a higher proportion of men (Table 5), the application of the models to this sample were aligned with the performance on the test sample (Table 6). Similarly, the national validation sample had a lower proportion of patients with NMSC and this may have contributed to the greater savings seen with the adjusted models in Table 6.

From the patient perspective, the models developed based on historical utilization by a local sample predicted a similar proportion of a national sample that would be covered by the various bundled payment models (Table 7). Notably, the median-based payment with indirect payment and mean-based adjusted models covered a similar proportion of the samples, but the former does not have the added burden of documenting or proving the conditions for adjustment. Similarly, from the provider perspective, a comparable proportion of providers in the samples had costs that were less than or equal to the theoretical median-based payment with indirect payment and the mean-based adjusted model with the discount. Again, the former has no need for documenting or proving gender or NMSC. None of the models covered every patient or every provider, but the purpose of the bundled payment is not to match current payment, but to underestimate it in order to "bend the cost curve."[52] It appears that the growth rate of health care spending is decreasing in association with changes in reimbursement, supported in part by the Affordable Care Act. Bundled payment models are complex and implementation includes the development of the payment amount as well as defining the services included and excluded from the bundle, defining the payment accountability (tracking who delivers care and how it is shared requires rapid access to claims data by clinicians and other staff), establishing quality measurement, and designing systems to provide up-to-date utilization data to providers that can be acted upon at the point-of-care.[37] This study showed that bundled payments have the potential to decreased cost with modest savings of $68,000 for adjusted mean-based payments or larger savings of more than $3.9 million if unadjusted median-based payments are applied.

Several limitations of the study deserve comment. One limitation is that patient and societal costs due to reduced productivity (indirect costs) were not included. In a 2004 study, the estimated indirect cost of AK was $172 million due to lost work days, restricted activity and lost activity by caregivers.[2] In addition, the claims data lack detailed information characterizing all aspects of the disease and assumptions are made about the accuracy of the diagnosis. Another limitation of this study is the use of a dataset that is restricted to western and central Pennsylvania and hence may not be generalizable to other areas of the country. However, the application of the bundled payment models, developed on this local sample, to the national sample resulted in reasonable performance regarding the proportion of patients that had costs above or below the bundled payment. Also, the proportion of individuals over 65 years old may be underrepresented in the local sample compared to larger samples and this may affect the reliability of the predicted bundled payments. The application of a bundled payment in a health care setting is complex and this study did not investigate the validity of the bundled payment models in the clinical setting. Further work is needed to determine the feasibility of this alternative reimbursement system in the dermatology clinic. Lastly, this study did not include data on disease outcomes and hopefully future studies will be able to integrate clinical outcomes and cost so that the efficacy and value of various management modalities can be assessed.

As healthcare systems and providers move toward population-based models of care, it is important to consider the evidence base for and costs of therapies. This study assessed the utilization of the various treatment modalities for AK and the associated disease-specific costs. The factors of the patient, disease, and healthcare system that may affect utilization and cost were also investigated. This level of detail may prove helpful as clinicians reflect on not only the benefits and risks of a management plan but also consider the cost for each individual in order to provide efficient and valuable care for individuals and communities. Alternative payment models can utilize economic principles to shift incentives from quantity, which is encouraged in the FFS model, to patient-centered and disease-oriented measures of quality as well as cost. Changes in reimbursement are happening and in the interim providers can make improvements in care delivery by promoting quality and reducing costs using recent clinical practice guidelines and other published evidence, which can identify opportunities to change or update practice.

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APPENDIX

TABLES 1 – 8

Table 1. Enrollment and demographic information for the local sample.

Characteristic	N (%) or mean ± SD
Age (years)	66.5 ± 12
Age Group	
Less than 30	434 (0.5)
30-39	1,494 (1.5)
40-49	7,062 (7.4)
50-59	21,541 (22.6)
60-69	30,499 (32.0)
70-79	21,433 (22.5)
80 and older	12,831 (13.5)
Gender	
Female	44,121 (46.3)
Male	51,173 (53.7)
Duration of Continuous Enrollment (days)	1,856 ± 891
History of skin cancer	
Yes	13,849 (14.9)
No	81,362 (85.4)
BCC	5,604 (5.9)
SCC	1,618 (1.7)

BCC = basal cell carcinoma, SCC = Squamous cell carcinoma, SD = standard deviation

Table 2. AK-related mean annual utilization and cost per patient for the local sample (2010-2012).

	Patients with claims, n (%)	Annual utilization per patient* mean ± SD	Annual cost per patient, ($)* mean ± SD
Outpatient Office Visit			
Any	56,786 (59.6)		
New	15,810 (27.8)	1.0 ± 0.2	322 ± 359
Consultation	1,500 (2.6)	1.0 ± 0.1	437 ± 458
Established	45,649 (80.4)	1.9 ± 1.4	322 ± 321
No claim for office visit (procedure only)	38,508 (40.4)	1.3 ± 0.6	207 ± 279
Prescription Therapy			
Any	5,756 (6.0)		
Fluorouracil	3,141 (54.6)	1.2 ± 0.5	311 ± 387
Imiquimod	2,050 (35.6)	1.3 ± 0.8	823 ± 574
Diclofenac	613 (10.6)	1.2 ± 0.7	414 ± 457
Ingenol	271 (4.7)	1.1 ± 0.3	847 ± 1,001
Procedures			
Cryotherapy			
Any	80,851 (84.8)		
One lesion (17000)	78,717 (97.4)	1.3 ± 0.7	129 ± 84
Two or more (17003)	50,233 (62.1)	1.3 ± 0.7	56 ± 69
15 or more (17004)	5,558 (6.9)	1.4 ± 0.7	299 ± 181

SD = standard deviation, * analyses are for patients with at least one claim for the service, total percentages may total more than 100% because one patient may have multiple claims in different categories. Descriptive statistics were performed for patients with a claim and did not include patients without a claim in study period.

Table 3. Mean three-year and annual total cost per patient for AK management stratified by age group and gender.

Characteristic	Mean total (3-year) cost per patient, ($)				Mean annual cost per patient ($)			
	Mean	SD	p-value	Median	Mean	SD	p-value	Median
Gender								
Female	347	458	<0.0001	209	248	292	<0.0001	173
Male	497	653		295	307	374		202
Age Group								
Less than 30	185	203		121	177	181		113
30-39	270	380		170	224	282		154
40-49	324	433		200	248	298		173
50-59	396	541	<0.0001	234	276	341	<0.0001	186
60-69	443	639		255	292	383		191
70-79	470	566		285	281	310		189
80 and older	457	572		271	289	330		191
Diagnosis of NMSC								
No	352	428	<0.0001	218	244	266	<0.0001	176
Yes	875	986		586	445	534		291

NMSC = non-melanoma skin cancer, SD = standard deviation

Table 4. Results of logistic regression of the patient, treatment, and provider factors associated with patients being in the upper fifth percentile of three-year total cost.

Variable	**Odds ratio (95%CI)**	**Coefficient [95%CI]**	**p-value**
Age	0.99 (0.98-1.00)	-0.005 [-0.012-0.002]	0.14
Gender male female	 1.86 (1.56-2.20) 1.0 [ref]	 0.62 [0.45-0.79] 0 [ref]	 <0.0001
Biopsy (quantity)	1.25 (0.88-1.77)	0.22 [-0.13-0.57]	0.21
Extensive cryotherapy* (quantity)	3.20 (3.0-3.41)	0.41 [0.39-0.43]	<0.0001
NMSC (quantity)	2.20 (2.08-2.32)	0.79 [0.73-0.84]	<0.0001
Prescription field therapy (quantity)	8.18 (7.28-9.19)	2.10 [1.98-2.22]	<0.0001
Zip code	1.00 (1.00-1.00)	0.00004 [0.00003-0.00006]	<0.0001
Physician identifier code	0.99 (0.99-0.99)	-0.0002 [-0.00027--0.00016]	<0.0001

*extensive cryotherapy is defined as a claim with CPT code 17004, destruction of >15 lesions, CI = confidence interval

Table 5. Characteristics of the test and validation samples used to develop and validate bundled payment models.

Characteristic	Test Population (1)	HM Validation Population (2)	MarketScan Validation Population (3)	p-value		
				1 v 2	1 v 3	2 v 3
Number of members	47,002	24,560	46,567			
Patient-years with AK claims	71,477	24,560	46,567		na	
Age, mean ± SD	66.2 ± 11.9	65.9 ± 11.8	54.3 ± 7.7	<.001	<.001	<.001
Age group, (n,%)						
20-29	207 (0.4)	73 (0.3)	149 (0.3)			
30-39	731 (1.6)	286 (1.2)	718 (1.5)			
40-49	3,389 (7.2)	1,605 (6.5)	4,013 (8.6)			
50-59	10,575 (22.5)	5,285 (21.5)	14,830 (31.9)			
60-69	14,990 (31.9)	7,892 (32.1)	26,857 (57.7)			
70-79	10,646 (22.7)	6,088 (24.8)				
80-89	6,464 (13.8)	3,331 (13.6)				
Gender				>0.99	<.001	<.001
Male (n, %)	25,356 (53.9)	14,072 (57.3)	24,648 (52.9)			
Female (n, %)	21,646 (46.1)	10,488 (42.7)	21,919 (47.1)			
NMSC*, (n,%)				<.001	<.001	<.001
Yes	5,732 (12.2)	2,495 (10.2)	4,079 (8.7)			
No	41,270 (87.8)	22,065 (89.8)	42,488 (91.3)			
Population Costs						
Three-year total ($)	18,804,830	6,475,533	12,026,134			
Outpatient, n (%)	16,742,283 (89.1)	5,740,329 (88.6)	11,667,960 (97.0)			
Drug and Pharmacy	2,062,547 (10.9)	735,204 (11.4)	358,274 (3.0)	<.001	<.001	0.01
Member-year costs ($)						
Mean ± SD	262 ± 336	263 ± 339	258 ± 368	.98	.07	.15
(95%CI)	(260.3-265.4)	(259.2-267.7)	(255.1-261.4)			
Median	173	174	179			
75th percentile	306	304	298			

*defined as NMSC prior to or during study period, NMSC = non-melanoma skin cancer, na = not applicable, SD= standard deviation

Table 6. Comparison of several bundled payment models on the basis of total cost for the samples.

Base Model	Model Adjustments	HM Test Population		HM Validation Population		MarketScan Population	
		Total 3-year spending	Difference (% of actual)*	Total 1-year spending	Difference (% of actual)*	Total 1-year spending	Difference (% of actual)*
Total cost of care [actual]		18,804,830	[ref]	6,475,533	[ref]	12,026,134	[ref]
75th percentile payment	**None**	21,860,526	+3,055,696 (+16.3)	7,511,430	+1,035,897 (+16.0)	14,242,051	+2,215,917 (+18.4)
	Gender- and NMSC-adjustment	25,688,894	+6,884,064 (+36.6)	8,815,107	+2,339,574 (+36.1)	15,495,895	+3,469,761 (+28.9)
50th percentile payment	**None**	12,377,672	-6,427,158 (-34.2)	4,253,055	-2,222,478 (-34.3)	8,064,007	-3,962,127 (-32.9)
	Indirect payment ($64)	16,952,200	-1,852,630 (-9.9)	5,830,339	-645,194 (-10.0)	11,112,818	-913,316 (-7.6)
	Gender- and NMSC-adjustment	16,206,040	-2,598,790 (-13.8)	5,558,058	-917,475 (-14.2)	10,271,521	-1,754,613 (-14.6)
Mean payment	**None**	18,726,974	-77,856 (-0.4)	6,434,720	-40,813 (-0.6)	12,269,077	+242,943 (+2.0)
	Gender- and NMSC-adjustment	18,794,223	-10,607 (-0.06)	6,447,014	-28,519 (-0.4)	11,957,712	-68,422 (-0.6)
	Gender- and NMSC-adjustment and 2% discount	18,418,338	-386,492 (-2.1)	6,318,230	-157,303 (-2.4)	11,718,558	-307,576 (-2.6)

nmsc = non-melanoma skin cancer, *indicates that if patients' actual annual cost did not change then it would fall within the alternative model payment cost in the alterative model. Costs have been adjusted to 2012 US dollars.

Table 7. Comparison of patient-years that are less than or equal to the payment allowed by the bundled payment across the three samples.

Base Model	Model Adjustments	Patient-years with an annual cost less than or equal to the model, n (%)			p-value		
		Test Population (1)	**HM Validation Population (2)**	**MarketScan Validation Population (3)**	**1 v 2**	**1 v 3**	**2 v 3**
75th percentile payment	**None**	53,662 (75.1)	18,505 (75.4)	35,386 (75.9)	>.99	.001	.17
	Gender- and NMSC-adjustment	58,053 (81.2)	20,043 (81.6)	36,795 (79.0)	.53	<.001	<.001
50th percentile payment	**None**	35,429 (49.6)	12,190 (49.6)	22,461 (48.2)	>.99	<.001	.001
	Indirect payment ($64)	46,990 (65.2)	15,923 (64.8)	30,273 (65.0)	>.99	>.99	>.99
	Gender- and NMSC-adjustment	44,008 (61.6)	15,184 (61.8)	27,417 (58.9)	.48	<.001	<.001
Mean payment	**None**	49,239 (66.9)	17,086 (69.6)	32,435 (69.7)	.14	.02	>.99
	Gender- and NMSC-adjustment	49,239 (68.9)	16,968 (69.1)	31,374 (67.4)	>.99	<.001	<.001
	Gender- and NMSC-adjustment and 2% discount	48,659 (68.1)	16,749 (68.2)	30,947 (66.5)	>.99	<.001	<.001

Table 8. Comparison of the provider payments that are less than or equal to the payment allowed by the bundled payment for each provider's patient group in the samples.

Base Model	**Model Adjustments**	**Providers with total patient cost less than or equal to the model^, n (%)**			**p-value**		
		Test Population (1)	**HM Validation Population (2)**	**MarketScan Validation Population (3)**	**1 v 2**	**1 v 3**	**2 v 3**
75^{th} percentile payment	**None**	377 (75.9)	220 (78.3)	2,880 (80.8)	>.99	.03	.93
	Gender- and NMSC-adjustment	412 (82.9)	238 (84.7)	2,997 (84.1)	>.99	>.99	>.99
50^{th} percentile payment	**None**	192 (38.6)	125 (44.5)	1,722 (48.3)	.33	.002	.65
	Indirect payment ($64)	308 (62.0)	194 (69.0)	2,419 (67.9)	.14	.03	>.99
	Gender- and NMSC-adjustment	280 (56.3)	175 (62.3)	2,153 (60.4)	.32	.25	>.99
Mean payment	**None**	342(68.8)	203 (72.2)	2,616 (73.4)	.95	.10	>.99
	Gender- and NMSC-adjustment	329 (66.2)	198 (70.5)	2,507 (70.3)	.66	.18	>.99
	Gender- and NMSC-adjustment and 2% discount	326 (65.6)	195 (69.4)	2,468 (69.2)	.49	.30	>.99

^indicates that if these providers had the same patients and similar costs of care then the provider would be reimbursed the same or more under the alternative model (denominator 497 providers). A negative difference indicates that less was spent with the alternative model; a positive difference indicates the alternative model had a higher cost.