Original Article

Documentation of Chemotherapy Infusion Preparation Costs in Academic- and Community-Based Oncology Practices

Diana I. Brixner, RPh, PhD,* Gary M. Oderda, PharmD, MPH,* Nancy A. Nickman, PhD,* Roy Beveridge, MD,[†] and James A. Jorgenson, RPh, MS,[‡] *Salt Lake City, Utah, and Fairfax, Virginia*

Key Words

Chemotherapy reimbursement, pharmacy costs, therapy management, fixed costs

Abstract

Significant changes in Medicare reimbursement for outpatient oncology services were proposed as part of the Medicare Modernization Act of 2003. The purpose of this study was to identify the "true cost" associated with drug-related handling for the preparation and delivery of chemotherapy doses to estimate the impact of changing reimbursement schema by Medicare. Two academic medical outpatient infusion centers and 2 community cancer centers provided data used to estimate all costs (excluding drug cost) associated with the preparation of chemotherapy doses. The data included both fixed costs (drug storage, space, equipment, and information resources) and variable costs (insurance management, inventory, waste management, pharmacy staff payroll, supplies, and shipping). The average cost for the preparation of chemotherapy doses across all sites was $34.27 (range, $32.08–$41.23). A time-and-motion study was also performed to determine what tasks were conducted by pharmacy staff and how much time was spent in the preparation of the top 15 chemotherapeutic drugs and regimens used in the 4 sites. Data from the 4 centers was projected to show that if 3,990,495 million chemotherapy infusions were administered to a national Medicare population in 2003, when multiplied by the average cost of preparation for infusions determined by the current study ($34.27), the estimated total annual cost to Medicare for chemotherapy preparation by pharmacists is $136,754,263.65. The pharmacists spent most of their days (90% or more) performing tasks directly related to the preparation of these agents. These data provide scientific support for the consideration of appropriate reimbursement for chemotherapy services provided by pharmacists to Medicare beneficiaries. (*JNCCN* 2006;4:197–208)

From *University of Utah Pharmacotherapy Outcomes Research Center, Salt Lake City, Utah; †Fairfax-Northern Virginia Hematology/Oncology, Fairfax, Virginia; and ‡University of Utah Hospital Pharmacy Services, Salt Lake City, Utah.

Submitted for publication July 21, 2005; accepted for publication January 11, 2006.

This research was supported in part by a grant from The Lewin Group, 3130 Fairview Park Drive, Suite 800, Falls Church, VA 22042, on behalf of the National Patient Advocate Foundation.

Correspondence: Diana I. Brixner, RPh, PhD, University of Utah Pharmacotherapy Outcomes Research Center, 421 Wakara Way, Suite 208, Salt Lake City, UT 84108. E-mail: dbrixner@hsc.utah.edu.

National health care expenditures in the United States for 2002 exceeded $1.6 trillion. Nearly 17% of these expenditures were paid for by Medicare, representing 38% of all public spending on health care.[1] Over the next 3 to 5 decades, as the average age of the population in the United States continues to increase, national health care expenditures are also expected to continue rising. As the primary payer for health care services provided to persons older than 65 years, Medicare and entities that fund the program have a major interest in containing and, where possible, reducing reimbursement growth costs. Health care spending for persons older than 65 years is estimated to be nearly 4 times that for those younger than 65 years, especially with regard to acute care services.[2] With the population of people older than 65 years expected to nearly double between 1999 (12.5%) and 2049 (21.3%), estimates of a 1% total annual age-mix adjusted increase in health care spending[2] have prompted changes in Medicare reimbursement strategies by the Centers for Medicare and Medicaid (CMS).

In addition to enacting legislation providing an outpatient prescription benefit program for Medicare beneficiaries, the Medicare Modernization Act (MMA) of 2003 will also significantly impact payment for oncology drugs and their administration.[3] Historically, less-than-optimal reimbursement for the administrative aspects of providing chemotherapy infusions has been compensated for through generous reimbursements for pharmaceuticals. The MMA changes the schema used for reimbursement from that of an average wholesale price (AWP) to that of an average sales price (ASP) plus a 6% markup. The MMA provides for increases in work and practice expense relative value units (RVUs) for those drug administration services typically billed by oncologists (32% for 2004 and 3% for 2005), in addition to MMA-mandated across-the-board updates to all physician fee schedule services of 1.5% in both 2004 and 2005.[3] This 1.5% update to the physician conversion factor had to be specifically enacted to counter an automatic reduction that was mandated to maintain budget neutrality.

The National Patient Advocate Foundation (NPAF) has appropriately raised concern that these changes may ultimately result in access problems for Medicare beneficiaries.[4] Assuming no changes in use, CMS estimated that the switch from AWP-based reimbursement in 2004 to ASP-based reimbursement in 2005 would result in an approximately 8% 1-year decrease in drug revenues to oncologists. This decrease is significant given that CMS estimated that drugs were responsible for about 70% of the typical oncologist's revenues in 2004. In addition, this decrease is added to what CMS estimated to be an approximately 12% reduction in oncology drug revenues in 2004.[4]

At issue is the appropriateness of payment levels for injectable chemotherapeutic and supportive drugs and their administration pursuant to the Medicare reimbursement changes.[5–7] Kleinke[8] has suggested that, "Medicare should reimburse providers for injectable drugs based on real numbers, not normative calculations." Given that the prevalence of cancer is not expected to decrease in the next few years[9] and that expenses for clinic-administered oncology drugs are also expected to continue increasing,[10] a thorough understanding of the total costs associated with administrative services involved in the preparation and delivery of oncology drug regimens is important to determine the adequacy of planned reimbursement changes. Administrative charges are more often associated with the delivery of the agent into the human body through infusion or intravenous push and, therefore, the costs of drug preparation, inventory and waste management, patient counseling, and therapy management are often overlooked. The present study was designed to measure and evaluate the drug-related handling costs (i.e., management costs) involved in preparing and delivering oncology drugs and regimens.

Methods

This study did not include drug purchasing and patient physical administration costs. A preliminary cost analysis was conducted through a local pilot study and then expanded to 3 additional oncology practice centers in the United States. To project the impact of these costs on national reimbursement, data from these 4 centers were then applied to a national Medicare population estimate of patients who had undergone oncology treatment.

The 4 sites were selected by location (distribution throughout the country), practice setting (academic vs. community), volume (higher to lower range of doses prepared), and the ability to produce 10 production occurrences of each of the identified most frequently used oncology and concomitant supportive drugs within a 1-month collection period. A study committee, including representatives from each of the 4 sites who could provide perspectives from reimbursement management, pharmacy practice, and nursing and physician care, was formed early in the study process. A general description of the 4 sites and a listing of the study site investigators are provided in Appendix A. The University of Utah received expedited review through the Institutional Review Board (IRB) and Clinical Cancer Investigational Committee for this study; all other sites received a waiver with no formal IRB evaluation because patients were not followed up and no identifying data were collected.

Chemotherapy agents can be given intravenously or orally. This study focused on the cost of chemotherapy drug preparation. Because preparation would be minimal for oral therapy, the study therefore focused on administration of chemotherapy agents through infusion or injection. Across all 4 sites, reimbursement was based on that for the actual pharmaceuticals and concomitant infusion. Each drug dose, given through individual injection or as part of an infusion with other drugs, had a separate infusion reimbursement charge. This was validated by the analysis performed in the MedStat MarketScan dataset where only 1.4% of claims were from the same calendar day for the same patient.[11] This study considered single doses, infusions, and injections to be equivalent and assessed the preparation cost of selected chemotherapy agents by this unit of measurement.

Each study site was instructed to review infusion schedules and identify the most commonly used chemotherapy and concomitant agents before taking the survey. A total of 22 chemotherapy and concomitant drugs were selected by highest volume of use as determined by each site, outlined in Appendix B. Concomitant supportive drugs were represented by classes of drugs, including the 5HT-3 antagonists, erythropoietic agents, colony stimulating factors, steroids, and bisphosphonates, and hydration, to take into consideration different formulary requirements of similar agents.

Appendix A. Study Centers and Investigators

Huntsman Cancer Institute, 2000 Circle of Hope, Salt Lake City, UT 84112-5550. Keri Fakata, PharmD, and Scott Silverstein, RPh, MS. The Huntsman Cancer Institute service area includes Utah, western Wyoming, southern Idaho, and eastern Nevada, with a population of 3 million people. There are over 55 cancer specialists, including 19 oncologists involved in research and patient care. Services provided include 1) a National Cancer Institute-designated clinical cancer center; 2) inpatient services at Huntsman Cancer Hospital (includes 50 patient care suites, high tech imaging, radiation oncology, and surgical services); 3) outpatient services include a chemotherapy infusion center, Family Cancer Assessment Center, Brain, Spine, Skull Base Tumor Service, Center for Children, Facial Prosthetics, Gastrointestinal Center, Melanoma Program, Radiation Oncology and Sarcoma Service, and Pain and Palliative Care Service.

Montgomery Cancer Center, 4145 Carmichael Road, Montgomery, AL 36106. E. Ashley Lambert, RPh, and Fletcher Bancroft, BA. The center includes Montgomery and surrounding communities, with a population of 600,000 people. Cancer specialists include 4 medical oncologists and 3 radiation oncologists. The following services are provided by the center: advanced radiation, chemotherapy, nutritional guidance, psychological support, onsite breast care and imaging center, a satellite clinic in Selma, Alabama, with one medical oncologist and one radiation oncologist, and a weekly oncology clinic in Troy, Alabama.

Fairfax-Northern Virginia Hematology/Oncology, 8503 Arlington Blvd, Fairfax, VA 22031. Robert Bretzel, RPh, and Roy Beveridge, MD. The service area includes western suburban Washington, DC, and Fairfax, Alexandria, Prince William, Loudon, and Fauquier counties, encompassing a population of 1.2 million. The 18 medical oncologists work from 7 different office locations. The services provided include chemotherapy, hematology, clinical research, and stem cell transplantation.

University of Wisconsin Comprehensive Cancer Center, 600 Highland Avenue, K4/658, Madison, WI 53792. Lee Vermulen, RPh, MS, and Sara Lentz, PharmD. The service area includes south and central Wisconsin and adjoining portions of Illinois with a population of 2.5 million. The center includes 26 medical oncologists, 13 radiation oncologists, 10 surgical oncologists, and 3 gynecologic oncologists.

Data Collection Methodology

A comprehensive survey with 4 sections was developed to capture all potential pharmacy-related costs associated with the production of oncology drug therapies across all 4 sites.

The first part of the survey collected information on patient demographics as well as chemotherapy and supportive agents provided at each site. A pharmacist or pharmacy manager at each site collected a wide variety of information for the most recent fiscal year, including annual patient counts and demographics, total annual dosages of drugs administered, and the costs associated with the preparation and delivery of oncology drugs. Virginia provided data from fiscal year January 1, 2003, to December 31, 2003; Utah and Wisconsin from fiscal year July 1, 2003, to June 30, 2004; and Alabama from fiscal year November 1, 2003, to October 31, 2004.

The second part of the survey focused on the total cost of drug-related handling associated with the delivery of chemotherapy. Fixed and variable costs were collected from each site as annualized data involving expenses associated with chemotherapy-infusion preparation. The key expenses identified involved drug storage; space rental; inventory, insurance, and waste management; payroll; equipment; supplies; information resources; and shipping. Detailed information was collected at each site on the total floor space used; the value of this space; the annualized value of storage facilities and preparation equipment; the cost of supplies; annual payroll and specialized labor costs; the annualized value of computers, phones, and fax machines; telecommunications costs; total inventory values; and costs associated with waste management, shipping, and information resources. The collection of data was standardized to ensure that all costs reported were accurate and consistent across all 4 facilities. Once the integrity of the collected data had been assured, the annual fixed costs information was analyzed in combination with the information on annual chemotherapy dose counts to determine a total cost per dose at each practice site and for all sites combined.

The third section of the survey was a time-and-motion (TM) study that evaluated the drug-related

Appendix B Average Number of Observations Per Site by Chemotherapy Drug and Supportive Agent

Chemotherapy Agents	Average Number of Observations per Agent	Concomitant Agents	Average Number of Observations per Agent
Carboplatin	12	Darbepoetin	14
Cisplatin	13	Dexamethasone	47
Cyclophosphamide	15	Dolasetron	38
Docetaxel	9	Epoetin	5
Doxorubicin	15	Filgrastim	2
Fluorouracil	16	Granisetron	19
Gemcitabine	12	Ondansetron	1
Herceptin	10	Pamidronate	5
Irinotecan	12	Pegfilgrastim	6
Leucovorin	13	Zoledronate	10
Oxaliplatin	9		
Paclitaxel	13		
Rituximab	13		
Topotecan	4		
Vincristine	8		
Total Observations	**173**	**Total Observations**	**145**

cost of producing chemotherapy. This study captured tasks performed by the pharmacist and technician during preparation of chemotherapy and concomitant drugs (Appendix C).[12] The tasks involved were identified through input from the advisory committee, practicing oncology pharmacists, technicians, and from administrators at the 4 sites. These tasks included therapy management, patient care, consultation, order entry, compounding, and production.

The final section of the survey was an observational TM study that evaluated an oncology pharmacist's typical shift. This included the principle tasks involved in drug preparation to capture the full shift of a pharmacist and provide perspective on drug preparation.

Appendix C Summary of Time-and-Motion Observation Categories

Therapy Evaluation	Patient Care
Order review by pharmacist	Patient communication
Collect patient data	Patient counseling
Evaluate adverse events	Oral premedication administration
Manage adverse events	Continuity of care
Consultation	**Order Entry/Compounding**
Physician consultation	Order entry
Other health care professional consultation	Compounding
Drug information	
Insurer communication	**Production/Evaluation**
	Product verification
	Production check
	Product special handling

National Projection Methodology

The proportion of Medicare patients with supplemental commercial insurance who were prescribed the same drug regimens observed at the study sites was estimated from the Medstat MarketScan database (www.medstat.com).[11] These data have been used to project the results to the United States population. Medstat MarketScan is a national database that includes health care claims for approximately 8 million people. Medstat used its MarketScan Medicare Supplemental and Coordination of Benefits (COB) Database to establish counts of Medicare-eligible individuals who received the specified chemotherapeutic agents, and counts of the total number of chemotherapy infusions administered during 2003. This database contains health insurance claims from current and former employer-sponsored health plans that provide supplemental insurance to Medicare-eligible employees and retirees and their dependents.

In 2003, the MarketScan Medicare Supplemental and COB Database contained information on 782,000 covered lives. From this database, all claims for outpatient administration of the indicated chemotherapeutic agents were selected based on national Healthcare Common Procedure Coding System (HCPCS) codes. Each claim was assumed to represent a single infusion (dose) of the coded agent, except where more than one claim for a given agent appeared for the same patient and date of service. Duplicate claims occurred on the same day for the same agent in only 1.4% of the total claims for the selected chemotherapeutic agents, and these were counted as a single infusion.

In addition to counts of infusions for each agent in the MarketScan Medicare Supplemental and COB Database, counts of patients who received selected agents at any time during 2003 were also generated. MarketScan-generated counts of infusions and patients were then projected to the national Medicare population in a 2-stage procedure. The first stage involved projection to the population of Medicare beneficiaries with employer-sponsored supplemental insurance. This was accomplished using person-level weights developed by Medstat for use with its MarketScan Medicare and COB Database. The covered lives represented in the database were treated as a stratified sample (by age, sex, region of country, and relation to policy holder) drawn from the national population with similar coverage, the size of which is estimated from the National Medical Expenditures Survey (NMES). The weights were calculated by Medstat as the inverse of the sample proportions within each stratum.

The second stage of the projection was from the population with employer-sponsored supplemental insurance to the entire Medicare population. This was accomplished by calculating the ratio of the latter to the former within age- and sex-specific strata in NMES, and then multiplying the age- and sex-specific counts of infusions and patients estimated in the first stage by these ratios. Given the distribution of patients on Medicare within Medstat MarketScan, the proportion of Medicare patients undergoing active treatment for cancer and the number of doses of chemotherapeutic agents that are provided annually on a national basis can be estimated. This estimation allowed the overall cost of the drug-related handling for the preparation and delivery of chemotherapy infusions to be calculated.

Results

Site Demographics

The demographic descriptions of the patients treated at the 4 sites are outlined in Table 1. In general, patients from Utah, Wisconsin, and Alabama were mostly Caucasian (90%–91%), with a predominance of female patients in Utah, Alabama, and Virginia (63% and 64%), and an almost equal distribution in Wisconsin (including 52% women). Ethnicity data were not available for Virginia. In Utah and Alabama, the dominant payers were private insurance (39% for Utah and 45% for Alabama) and Medicare (37% for Utah and 40% for Alabama), whereas in Virginia and Wisconsin private insurance dominated at 67% and 54%, respectively, with Medicare the second greatest payer at 31% and 34%, respectively. Across all states, Medicare accounted for an average 35% of study site patients.

Total Cost Analysis

The total costs within each category were divided by the number of chemotherapy doses given at each site

Table 1 Demographic Description of Cancer Center Patients

	Alabama	Utah	Virginia	Wisconsin
Annual patient count	**4,447**	**1,124**	**9,839**	**1,963**
Male	37.0%	37.0%	36.0%	48.0%
Female	63.0%	63.0%	64.0%	52.0%
Ethnicity - Hispanic	0.2%	5.0%	**NA**	0.7%
Ethnicity - Black	24.1%	1.0%	**NA**	2.6%
Ethnicity - Asian	0.3%	3.0%	**NA**	0.7%
Ethnicity - Caucasian	67.0%	91.0%	**NA**	90.1%
Ethnicity - Other	8.4%	0.0%	**NA**	5.1%
Payment				
Cash	7.0%	6.0%	0.5%	1.0%
Private insurance	45.0%	39.0%	67.0%	54.0%
Medicaid	6.0%	14.0%	1.0%	4.0%
Medicare	40.0%	37.0%	30.8%	34.0%
Indigent	2.0%	4.0%	0.5%	9.0%

and across sites to provide an average cost per dose for the drug-related handling costs involved in the preparation of chemotherapy drugs. The most critical number, which was applied to all individual cost categories, was the number of chemotherapy doses given per year at each site. Therefore, to ensure consistency, the definition of *dose* was given much consideration by the investigators across all 4 sites.

Table 2 lists the numbers of unique cancer patients seen at each site per year, chemotherapy doses delivered per year, and supportive therapy doses provided (e.g., antinausea drugs, steroids, blood complements). For the cost analysis, only the chemotherapy doses were considered. For example, the 1,124 cancer patients served per year by the University of Utah outpatient clinic received 6,958 doses of chemotherapy (6.2 doses per patient). A comparison across the 4 sites showed that Utah, Alabama, and Wisconsin had a similar ratio of number of chemotherapy doses given per cancer patient. With regard to supportive doses, the number of supportive doses per chemotherapy dose varied from a high of 2.8 at Utah to a low of 0.7 at Virginia. Variability among the sites in the use of oral and intravenous agents most likely led to this difference.

Table 3 provides a summary of total costs by site and across all sites for each of the cost analysis categories. In addition to reporting the site-specific costs for each category, per dose costs per expense category were also calculated based on a summary cost per category for each site divided by the annual number of doses given at each site.

Drug Storage: Drug storage was calculated by summarizing costs for required storage units (e.g., cabinets, freezers, refrigerators) multiplied by the number of units and divided by the number of useful years of each unit. Drug storage requirements (e.g., fixed shelving, refrigerators, dispensing cabinets) were similar across 3 of the sites. However, Alabama reported only built-in cabinets, no PIXIS system, and only a refrigerator for storage. Average storage costs per chemotherapy dose ranged from $0.70 at Utah to $0.03 at Alabama.

Table 2 Number of Patients and Treatments Across Four Sites

Treatment	Alabama	Utah	Virginia	Wisconsin
Total patients	4,447	1,124	9,839	1,963
Total doses, chemotherapy	28,236	6,958	32,636	17,072
Total doses, supportive	40,560	19,745	22,272	32,247
Chemotherapy doses per patient	6.4	6.2	3.3	8.7
Supportive doses/ chemotherapy dose	1.4	2.8	0.7	1.9

Space Rental: Space rental was calculated based on total space (square footage) used, including clean rooms, storage, and office space. Rental fees incorporated both maintenance and utilities. Between the 2 community-based centers, Virginia ($0.86) had a much higher cost per square foot than Alabama ($0.70), as would be expected because of differences in cost of living. Between the academic-based centers, Utah ($0.65) had a higher cost per square foot than Wisconsin ($0.53). However, because Wisconsin owns their building, costs were calculated based on building depreciation rather than rent.

Inventory Management: Inventory management costs were calculated by taking the annual physical inventory for chemotherapy agents and all concomitant agents provided during treatment, multiplied by a 7% opportunity cost. The labor cost (hours times salary plus benefits) of personnel involved in inventory management was then added to this number. Physical inventories at each site balanced well against the number of doses given among sites. All 4 sites agreed that inventory management is a balance between the amounts of on-hand inventory and the staff's investment in better management of that inventory.

Insurance Management: Insurance management was calculated based on staff hours spent on this task, multiplied by salary and benefits. Labor costs were the only cost collected for insurance management. As the data variance show, Virginia ($8.87) and Alabama ($8.36) had a significantly larger amount of staff dedicated to insurance management, coding, and reimbursement, again driven by a substantially larger patient base more typical of a community-based cancer setting. On the other hand, the hospital outpatient sites reported that insurance management was more decentralized across their health system, which perhaps lowers their insurance management costs but does not necessarily lead to greater efficiency.

Waste Management: To calculate annual waste management costs, uncompensated annual drug waste (i.e., drug prepared but not given to patient) was added to

Table 3 Total Costs Per Site and Across All Sites

	Alabama		Utah		Virginia		Wisconsin		All Sites	
	Total	Per Dose	Total	Per Dose	Total	Per Dose	Total	Per Dose	Total	Average Per Dose
Storage										
Facilities cost	$880.00	$0.03	$4,875.00	$0.70	$5,167.00	$0.16	$5,668.50	$0.33	$16,590.50	$0.20
Total	**$880.00**	**$0.03**	**$4,875.00**	**$0.70**	**$5,167.00**	**$0.16**	**$5,668.50**	**$0.33**	**$16,590.50**	**$0.20**
Space rental										
Annual cost	$19,639.77	$0.70	$3,857.00	$0.65	$28,163.40	$0.86	$9,111.25	$0.53	$60,771.42	$0.72
Total	**$19,639.77**	**$0.70**	**$3,857.00**	**$0.65**	**$28,163.40**	**$0.86**	**$9,111.25**	**$0.53**	**$60,771.42**	**$0.72**
Inventory management										
Labor cost	$33,878.00	$1.20	$8,331.00	$1.20	$39,986.00	$1.23	$8,853.00	$0.52	$91,048.00	$1.07
Inventory value	$106,009.40	$3.75	$21,860.51	$3.14	$44,509.92	$1.36	$30,567.81	$1.79	$202,947.64	$2.39
Total	**$139,887.40**	**$4.95**	**$30,191.51**	**$4.34**	**$84,495.92**	**$2.59**	**$39,420.81**	**$2.31**	**$293,995.64**	**$3.46**
Insurance management										
Labor cost	$235,996.00	$8.36	$43,050.00	$6.19	$289,536.00	$8.87	$64,575.00	$3.78	$633,157.00	$7.46
Total	**$235,996.00**	**$8.36**	**$43,050.00**	**$6.19**	**$289,536.00**	**$8.87**	**$64,575.00**	**$3.78**	**$633,157.00**	**$7.46**
Waste management										
Labor cost	$3,170.00	$0.11	$25,827.00	$3.71	$2,059.00	$0.06	$18,659.00	$1.09	$49,715.00	$0.59
Annual drug waste	$58,923.00	$2.09	$2,500.00	$0.36	$35,000.00	$1.07	$15,000.00	$0.88	$111,423.00	$1.31
Other costs	$38,320.00	$1.36	$0.00	$0.00	$88,784.00	$2.72	$71,253.00	$4.17	$198,357.00	$2.34
Total	**$100,413.00**	**$3.56**	**$28,327.00**	**$4.07**	**$125,843.00**	**$3.86**	**$104,912.00**	**$6.15**	**$359,495.00**	**$4.24**
Payroll										
Payroll cost	$305,565.00	$10.82	$147,172.48	$21.15	$351,876.00	$10.78	$377,580.00	$22.12	$1,182,193.48	$13.92
Total	**$305,565.00**	**$10.82**	**$147,172.48**	**$21.15**	**$351,876.00**	**$10.78**	**$377,580.00**	**$22.12**	**$1,182,193.48**	**$13.92**
Equipment										
Hood cost	$3,100.00	$0.11	$1,250.00	$0.18	$1,200.00	$0.04	$1,061.00	$0.06	$6,611.00	$0.08
Venting cost	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$600.00	$0.04	$600.00	$0.01
Inspections	$1,200.00	$0.04	$350.00	$0.05	$1,100.00	$0.03	$350.00	$0.02	$3,000.00	$0.04
Computer	$4,500.00	$0.16	$3,000.00	$0.43	$3,000.00	$0.09	$3,000.00	$0.18	$13,500.00	$0.16
Fax	$250.00	$0.01	$250.00	$0.04	$250.00	$0.01	$250.00	$0.01	$1,000.00	$0.01
Phone	$150.00	$0.01	$100.00	$0.02	$150.00	$0.00	$100.00	$0.01	$500.00	$0.01
Dispensing	$13,452.00	$0.48	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$13,452.00	$0.16
Telecom cost	$1,800.00	$0.06	$1,944.00	$0.28	$4,003.00	$0.12	$2,330.00	$0.14	$10,077.00	$0.12
Total	**$24,452.00**	**$0.87**	**$6,894.00**	**$1.00**	**$9,703.00**	**$0.30**	**$7,691.00**	**$0.45**	**$48,740.00**	**$0.58**
Supplies										
Annual cost	$98,122.00	$3.48	$22,019.00	$3.16	$77,382.00	$2.37	$40,102.00	$2.35	$237,625.00	$2.80
Total	**$98,122.00**	**$3.48**	**$22,019.00**	**$3.16**	**$77,382.00**	**$2.37**	**$40,102.00**	**$2.35**	**$237,625.00**	**$2.80**
Shipping										
Annual cost	$0.00	$0.00	$0.00	$0.00	$74,288.00	$2.28	$0.00	$0.00	$74,288.00	$0.87
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$74,288.00**	**$2.28**	**$0.00**	**$0.00**	**$74,288.00**	**$0.87**
Information resources										
Annual cost	$1,200.00	$0.04	$500.00	$0.07	$500.00	$0.02	$500.00	$0.03	$2,700.00	$0.03
Total	**$1,200.00**	**$0.04**	**$500.00**	**$0.07**	**$500.00**	**$0.02**	**$500.00**	**$0.03**	**$2,700.00**	**$0.03**
Grand Total	**$926,155.17**	**$32.80**	**$286,885.99**	**$41.23**	**$1,046,954.32**	**$32.08**	**$649,560.56**	**$38.05**	**$3,023,480.04**	**$34.27**

other listed items related to drug waste management (e.g., items necessary for toxic waste removal). The total was based on the cost of staff hours involved in waste management multiplied by salary and benefits. Waste management is handled differently among sites. For example, labor costs allocated to waste management varied depending on who was responsible. The variable "drug prepared and not used" was a process-related outcome that also varied between sites. At Utah ($4.07/dose), most waste disposal is handled centrally through the campus and is not charged back to the oncology unit. This was not the case at the other sites, as evidenced by their per dose costs. Based on patient volume, the waste-management costs of the 2 academic-based centers were the most expensive.

Payroll: Payroll was calculated based on hours worked by pharmacists and pharmacy technicians multiplied by hourly wage, with cost of benefits then added. Labor costs for pharmacists and technicians were the only costs collected for payroll because other labor costs were allocated to their specific cost centers, such as insurance or waste management. The ratio of pharmacy staff to output varied among sites. The staff per dose costs were very similar between the 2 academic-based medical centers (Utah, $21.15/dose; Wisconsin, $22.12/dose) and between the 2 community-based centers (Alabama, $10.82/dose; Virginia, $10.78/dose). The academic-based centers showed higher staff per dose costs, perhaps because the academic medical center oncology pharmacists, in line with the academic mission of the university, had greater expectations of being involved in teaching and clinical consultation.

Equipment: Annualized costs for equipment were calculated for 2 main items: biologic safety cabinets (BSC) and ventilation equipment. This equipment is used for the aseptic and sterile production of injectable drug products and for protecting workers from dangerous and toxic contamination caused by airborne drug particles. Although data on the cost of infusion pumps were collected, they were not included in the analysis because these devices were considered a direct cost associated with the administration and not preparation of the chemotherapy agent. The cost for BSCs was calculated by dividing the cost of the cabinet by the years of useful life. The price of venting installation, also divided by the years of depreciation, was added to this cost. The cost of annual inspections was also included. Additional minor equipment, including computers, phones, and faxes, were added along with annual telecommunication costs. Equipment costs were consistent among the sites at $1.00 or less per dose.

Supplies: Data on supplies were provided as annual costs per item; therefore, the quantity of each item was multiplied by unit or bulk costs to provide the annual costs for all supplies listed. An interesting determination was Utah's unique use of the PhaSeal system (Carmel Pharma, Sweden), which protects health care workers against exposure to chemotherapy agents. This is a disposable system that contributes approximately $10 to $15 to the total cost of an infusion. Only the components charged to and used by the pharmacy were included in this study. The components used by nursing staff for the actual patient infusion were excluded.

Shipping: Only one site (Virginia) used courier services extensively to deliver chemotherapy infusions to clientele. The cost of this service was included and calculated as part of the total average cost per dose for Virginia because its efficiencies in other areas were most likely caused by this process of delivery. Shipping costs for the Virginia site were $74,288 for 1 year, or $2.28 per dose.

Information Resources: Because Utah and Wisconsin both reported a highly developed but distinct Drug Information Service that was separate from the chemotherapy center, financial allocation of information resources was difficult. Virginia ($0.02/dose) reported a cost of $500 per year for information resources. Utah ($0.07/dose) and Wisconsin ($0.03/dose) considered this to be a reasonable estimate. Although Alabama reported costs of $1,200 per year for information resources, the cost per dose was similar to the other sites at $0.04 per dose.

Total fixed costs per site (Table 3) were comparable for Alabama ($32.80/dose), Virginia ($32.08/dose), and Wisconsin ($38.05/dose), but were higher for Utah ($41.23/dose). This difference was primarily caused by a smaller number of doses spread over their fixed costs and the use of the PhaSeal system. As the Occupational Safety and Health Administration standards progress toward increasing safety requirements for the preparation of chemotherapy agents, several major oncology centers are beginning to use the PhaSeal system and other protective mechanisms. Without the PhaSeal system, Utah's cost would be

$39.08 per dose, which is closer to that of the other sites. Based on these figures, a study-derived average cost of $34.27 was determined by calculating the cost per dose of each component and then adding these together to determine the overall cost per dose for pharmacy preparation.

Across the categories, the most expensive components of drug preparation were payroll for the oncology pharmacists and technicians ($13.92) followed by insurance management, with an additional labor cost of $7.46. Inventory management, waste management, and supplies all contributed between $2.80 and $4.24 to the aggregate cost of preparation. Space rental, storage, equipment, shipping, and information resources all contributed less than $1.00.

Table 4 Time-and-Motion One-Day Pharmacist Activity Summaries (in hours)

	Alabama	Virginia	Utah	Wisconsin	Average
Therapy evaluation	1.12	3.58	3.76	1.63	2.52
Consultation	3.15	1.16	2.26	3.47	2.51
Patient care	0.05	0.95	1.18	2.53	1.18
Order entry/ compounding	2.61	4.22	1.44	2.14	2.60
Production/ evaluation	0.98	0.09	1.38	1.31	0.94
Interruption/ other	0.33	0.24	0.85	0.28	0.43
Total hours	8.25	10.25	10.87	11.37	10.19

Time-and-Motion Analyses

Analysis of Chemotherapy Drugs, Regimens, and Concomitant Supportive Agents: TM observational data were collected on the production of the most frequently used/prescribed chemotherapy drugs, regimens, and concomitant agents at each of the 4 sites during methodology development (Appendix A). Observations of the drugs listed in each category were collected over a 3-week period to determine frequency of use.

The preliminary observation period showed more than 10 production occurrences of each chemotherapy drug per site. Only topotecan was used less than expected, which could have been caused by a change in commonly used regimens between the preliminary data collection period and the observation period. For concomitant blood-cell stimulator therapy, darbopoetin was consistently observed more often than epoetin, and pegfilgastrim was used more often than filgastrim. At Utah and Alabama, the primary agents used for antiemetic therapy were dolasetron and granisetron, respectively. Zoledronate was observed more often than pamidronate in patients with advanced-stage cancer requiring treatment of bone metastases. In general, the observations assured investigators that the TM analysis accurately observed the desired chemotherapy and concomitant agents used in treatment.

Pharmacist Activities Analysis: A 1-day TM study of pharmacists' cognitive and production activities was also conducted at each of the 4 sites. Results listed in Table 4 indicate that most pharmacists' shift activities were related to the clinical and professional provision of oncology pharmacy services and the preparation of chemotherapeutic agents for administration. The TM data collection process focused on 17 categories of activities. However, for ease of evaluation, TM results were consolidated into 5 general categories of activities (Appendix C). In conjunction with other key medical intermediaries (nurses, physicians, and insurers), pharmacists evaluated medical orders for appropriateness, supervised production and compounding, and provided direct patient care (communication, counseling, and premedication administration) during their shift. In all 4 sites, less than 1 hour was spent on other activities or interruptions outside of the tasks involved in drug preparation. This validates the need to consider these services for reimbursement and, for this study, acknowledges that full pharmacy staff payroll should be included in the aggregate costs and was appropriate to include in the total cost analysis portion of the study.

As the TM observation of activity indicates, pharmacists from each site spent similar amounts of time in cognitive and production functions. The pharmacists at the academic-based medical centers seemed to spend more time per observation performing direct patient care and cognitive professional functions than did those at the community-based sites. However, the differences in the amount of time spent per observation in each activity were most likely caused by the variability of chemotherapy complexity and oncology pharmacy practice structure, leading to disparities in the actual duties performed by pharmacists at each site. Each site is expected to be unique, with some commonalities in the manner of oncology pharmacy practice. However, given the highly technical nature of oncology pharmacy practice, structural and functional differences are more likely to cause variability across professional practice sites.

National Projection Results

Drug-specific counts of infusions and patients are provided in Table 5. The MedStat MarketScan database showed that claims for 63,542 infusions of the selected agents during 2003 were for Medicare patients with supplemental commercial insurance. Fluorouracil was the most frequently administered agent, followed by leucovorin, carboplatin, and paclitaxel. Using the projection methodology described previously, the unweighted counts of persons and infusions based on those in the Medstat MarketScan Medicare and COB Database were used to estimate a projection to the total Medicare population of 427,605 potential patient cases and 2.7 million infusions administered to Medicare beneficiaries.

National cost projection calculations are outlined in Table 6. To complete the national projection, the proportions of chemotherapy costs for the top 15 (i.e., most frequently used) observed agents and their relationship to total cost of chemotherapeutic agents was calculated at 2 of the 4 sites. The top 15 represented 74% of chemotherapy doses administered at Utah and 58% administered at Virginia. An average estimate of 66% was then multiplied by the Medstat MarketScan Medicare estimate of 427,605 Medicare-eligible beneficiaries who might receive 2,651,824 estimated infusions. Therefore, based on a projected 3,990,495 chemotherapy infusions administered to Medicare-eligible beneficiaries and a study-derived fixed cost estimate of $34.27 per administered chemotherapy dose, the cost of drug preparation alone (excluding cost of drug agent) was estimated to be in the range of $130 to $140 million per year. Using a sensitivity-analysis approach, if the costs from the lowest and highest cost sites ($32.08 and $41.23, respectively) were applied to the almost 4 million infusions, the total cost would be between $128 million and $164 million.

Discussion

The debate continues about appropriate reimbursement for drugs versus that for service involved in the administration of chemotherapy agents to Medicare beneficiaries. This study was designed to assess the

Table 5 Counts of Medicare Persons and Infusions by Chemotherapeutic Agent

	Unweighted Counts		Projection to Population with Medicare and Commercial Supplemental Insurance		Projection to Total Medicare Population	
Chemotherapeutic Agent	Persons	Infusions	Persons	Infusions	Persons	Infusions
Carboplatin	1,453	6,415	21,928	97,648	59,389	263,194
Cisplatin	363	1,550	5,786	24,654	15,160	63,377
Cyclophosphamide	909	4,449	13,841	68,522	38,187	190,421
Docetaxel	849	5,040	12,869	76,849	35,333	211,862
Doxorubicin	694	2,488	10,603	37,354	29,256	103,356
Fluorouracil	1,341	11,998	20,653	187,448	56,202	507,111
Gemcitabine HCL	872	5,405	13,244	81,693	36,769	226,345
Irinotecan	398	3,004	6,155	47,212	16,223	123,198
Leucovorin calcium	787	8,408	12,154	132,415	32,721	351,443
Oxaliplatin	12	33	245	792	724	2,573
Paclitaxel	1,070	6,006	16,121	91,360	43,601	245,757
Rituximab	864	4,297	12,791	62,484	35,700	174,878
Topotecan	126	1,158	1,828	17,171	5,256	49,745
Trastuzumab	116	1,857	1,692	28,049	4,855	78,178
Vincristine sulfate	436	1,434	6,585	21,718	18,229	60,387
Totals	10,290	63,542	156,495	975,369	427,605	2,651,825

Table 6 National Projection of Drug Preparation Costs for Medicare Patients Receiving Chemotherapy

		Patients	Infusions
Total (from MedStat projection)		427,605	2,651,824
Proportion of chemotherapy infusions from top 15 agents	0.66		
Projected Medicare chemotherapy infusions			3,990,495
Infusions times calculated cost/infusion from current study ($34.27)			$136,754,263.65

costs attributed to drug-related handling in the preparation and delivery of chemotherapy agents, and to provide accurate, scientifically sound data to support appropriate reimbursement for these services to health care providers of Medicare beneficiaries.

Several critical steps were taken to ensure optimal site selection. First, sites were selected to provide a balance among 1) the 2 key areas of community- versus academic-based medical centers; 2) geographic distribution; and 3) type of cancer care service. Sites were included from the East, South, Midwest, and West. Two sites provided outpatient cancer care as part of an academic medical center, and 2 sites were community-based cancer centers. Although a considerable amount of time was spent in this phase of the study, the number of centers surveyed had to be small because of budget and time limitations and, therefore, the selected centers are representative only of themselves. Despite this, the concordance among the 4 sites provides a strong sense of internal validity and increases the usefulness of this information toward more global policy discussions.

Implications for Public Policy and Future Research

The primary purpose of the national projections was to show the magnitude of cost related to drug preparation across the entire Medicare population. Extrapolation of figures from the national Medicare population with supplemental commercial insurance to the Medicare population as a whole showed that an estimated 4 million doses of chemotherapy agents are delivered annually at a preparation cost of $137 million. With more than $300 billion anticipated in 2005 for annual Medicare spending,[13] lawmakers and government officials must focus on achieving long-term financial viability of this important program. Consistent with that priority, decision makers have sought to determine critical and cost-effective services that must be covered to achieve short- and long-term efficiency and cost avoidance. These services are typically defined as those activities that are essential to the delivery of covered items and services and those that minimize additional medical complications or inpatient hospitalizations. Many of the activities conducted by pharmacists are intended to increase efficiency and decrease medical risk. However, these benefits come at a significant cost currently not reimbursed by CMS.

CMS officials have recently proposed an additional payment of two percentage points of ASP for the otherwise non-covered pharmacy costs borne by hospital outpatient departments, which would be a step in the right direction in offsetting some of the presented costs. CMS officials are also anticipated to continue reviewing pharmacy-related costs generated in physician office settings where, for cancer treatment, most Medicare beneficiaries are seen because of capacity, cost, and convenience.

Centers selected for the present study may resemble other cancer care centers that were not surveyed; yet much chemotherapy preparation is also performed in physician-based clinics and administered by non-pharmacists. Efforts were made to develop a method for collecting data that could be replicated in other models of chemotherapy preparation. Clearly, location of chemotherapy preparation and administration remains an area for further study and delineation.

The present study did not collect data on either a patient-specific or drug-specific basis. Knowledge of personnel and other fixed and variable costs relative to the type of patient and chemotherapy production would also be necessary to understand which therapies are more or less expensive to produce. The national cost projections were supported by an extrapolation from 2003 data in the Medstat MarketScan Medicare and COB Database. The findings should be updated and validated with information from another database. SEER-Medicare (Surveillance, Epidemiology, and End-Results), which links population-based cancer registry clinical information with Medicare claims information, may be one database to consider in a future study. In summary, the findings of the present analysis should advance the current work by Medicare leaders and assist in future strategies toward resource-based reimbursement.

Limitations

This study was conducted in only 4 oncology centers across the United States. Although type of service and geography were considered, these results may not be truly representative. For fixed cost analysis, contract negotiation and cost of goods may vary across the sites. Practice variation would also be expected among the 4 sites. Ideally, these results should be validated in additional sites.

The Medstat MarketScan Medicare and COB Database were used as the basis for national projections of chemotherapy use. These databases are most representative of the population of Medicare beneficiaries who have employer-sponsored supplemental insurance. Thus, projections to this population segment can be made with a high level of confidence. Further projection to the entire Medicare population requires the assumption that employer-sponsored supplemental insurance coverage does not substantially alter oncology treatment relative to other types of supplemental coverage or lack of secondary insurance. A correlation is likely between use of medical services and level of insurance coverage; however, whether oncology treatment is as sensitive to coverage as is mental health treatment, for example, is not certain.

These estimates should be used cautiously, with the understanding that they may potentially overestimate chemotherapy use among Medicare beneficiaries. However, they may provide a useful first approximation pending further research using other sources such as the SEER-Medicare database.

Drug-handling costs were identified collectively across the 15 drugs studied. For CMS to take action toward reimbursement strategies for individual drugs based on these data, the inevitable differences should be studied, because each individual chemotherapy agent requires unique preparation, administration, and patient care components.

Conclusions

The Medicare Modernization Act of 2003 has already made a significant impact on the delivery and reimbursement of care for Medicare patients undergoing chemotherapy. Although drug reimbursement has decreased, reimbursement for administrative services of chemotherapy has not adequately accounted for this offset. To validate the magnitude of this offset, primary research on the actual components and costs of the delivery of care must be undertaken. This article shows that the pharmacy-related costs of drug preparation are significant: $34.27 per chemotherapy dose with a potential national impact of $137 million dollars per year. These important costs should not be overlooked as reimbursement for chemotherapy administration is assessed.

References

1. Cowan C, Catlin A, Smith C, et al. National Health Expenditures, 2002. Health Care Financ Rev 2004;25:143–166.
2. Keehan SP, Lazenby HC, Zezza MA, et al. Age estimates in national health accounts. Health Care Financ Rev December 2004. Available at: http://www.cms.hhs.gov/healthcarefinancingreview/downloads/keehan.pdf. Accessed January 30, 2006.
3. Medicare Prescription Drug, Modernization, and Improvement Act of 2003. Public Law No. 108-173 (2003).
4. Davenport-Ennis N. National Patient Advocate Foundation. September 24, 2004 (Letter). NPAF makes comments on CMS proposed rule CMS-1429-P. Available at: http://www.npaf.org/news.php?p=297. Accessed January 2006.
5. Iglehart JK. The new medicare prescription drug benefit—a pure power play. N Engl J Med 2004;350:826–833.
6. Doherty RB. Assessing the new medicare prescription drug law. Ann Int Med 2004;141:391–395.
7. Meyer BM, Cantwell KM. The Medicare Prescription Drug, Improvement, and Modernization Act of 2003: implications for health-system pharmacy. Am J Health Syst Pharm 2004;61:1042–1051.
8. Kleinke JD. Re-naming and re-gaming: medicare's doomed attempt to reform reimbursement for injectable drugs. Health Affairs 2004. Available at: http://content.healthaffairs.org/cgi/reprint/hlthaff.w4.561v1. Accessed January 2006.
9. Weir HK, Thun MJ, Hankey BF, et al. Annual report to the nation on the status of cancer, 1975-2000, featuring the uses of surveillance data for cancer prevention and control. J Nat Cancer Inst 2003;95:1276–1299.
10. Hoffman JM, Shah ND, Vermeulen LC, et al. Projecting future drug expenditures—2005. Am J Health Syst Pharm 2005;62:149–167.
11. Chang S, Long SR, Kutikova L, et al. Estimating the costs of cancer: results on the basis of claims data analyses for cancer patients diagnosed with seven types of cancer during 1999 to 2000. J Clin Oncol 2004;22:3524–3530.
12. Roberts MJ. Work measurement. In: Brown TR, Smith MC (eds). Handbook of Institutional Pharmacy Practice. Baltimore, MD: Williams & Wilkins; 1986, p. 90–110.
13. Annual Report of the Boards of Trustees. Centers for Medicare & Medicaid Services Web site. Available at www.kff.org/medicare/loader.cfmPurl-/commonspot/security/getfile.cfm&PageID=33319. Accessed January 30, 2006.