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The economics of blood: Gift of life or a commodity?

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Objectives: To calculate the costs of blood collection, testing, storage, and transfusion in Greece.
Methods: Costing information was collected from two large public hospitals, in Athens and Crete, that also act as blood banks. Given that private health care accounts for 40 percent of total health spending, the same costs were also considered in a private setting by collecting key reagent cost data from a leading private hospital in Athens. Mainly direct costs were considered (advertising campaigns, personnel, storage and maintenance, reagent costs, transportation costs from blood bank to end-use hospitals, and cross-matching and transfusion costs in receiving hospitals) and some indirect costs (opportunity cost of blood donorship).
Results: Captive donorship accounts for over 50 percent of the national blood supply. A unit of blood transfused would cost between €294.83 and €339.83 in public hospitals and could reach €413.93 in a private facility. This figure may be an underestimate, as it excludes opportunity costs of blood transfusion for patients and the healthcare system.
Conclusions: Blood has a significant cost to the health system. Policy makers and practitioners should encourage its rational use, build on current policies to further improve collection and distribution, encourage further volunteer donorship in Greece, and also consider alternatives to blood where the possibility exists.

Keywords: Blood, Blood transfusion, Cost of blood, Public good, Gift, Hemotherapy, Direct and indirect costs, Health policy

Economists in the 1960s argued that blood was a private good and that market principles would ensure a Pareto optimal allocation and distribution (5;6). Paid donations would increase blood donorship but could lead to negative externalities in terms of increases in transmission rates of infectious disease. Others have argued that blood is not a private but rather a public good (47), suggesting that governments should intervene to provide and distribute it according to need rather than ability to pay. The notion of blood as a public good is also related to its scarcity and the requirements for safety and quality at national and EU levels (36) and for donations to be voluntary and unpaid (4;35).

Although blood is donated free in EU countries, its collection, production, storage, distribution, and transfusion are

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associated with significant costs to the healthcare system (16;22;27;37;48). Safety in blood transfusion is paramount because of the risks and costs involved (33;34). Three percent of those transfused react to the transfused blood. Some of these reactions can be fatal (e.g., hemolysis); although the risk of a reaction or of contracting a major infectious disease is very small (20;28;45;52), it is associated with significant treatment costs (14;15;17;19;46). The prevalence of transfusion-transmitted infections was relatively high in Greece but has declined considerably in recent years, due to improved vigilance (38;40). Seropositive donors are predominantly male, aged 35–45 years, and first-time donors giving blood for family credit (captive donors), although the shares of females, repeat donors, and immigrants are increasing (23;41).

Since 1974, blood is collected and distributed free of charge in Greece, under the direct supervision of the National Health Service (NHS) through public hospitals and blood transfusion centers (27), and any private blood banks have been abolished by legislative amendment (39). Blood donors are not remunerated. Despite rises in voluntary donorship and the decreasing reliance on captive donorship and army recruits, scarcity remains a key concern and a national health policy issue as the country continues to have a deficit in blood and blood products. Seasonal variations in demand, patient groups requiring multiple transfusions annually (e.g., thalassemia patients), a continued over-reliance on captive donorship, and frequent blood misuse or waste (38) contribute to this trend.

This study calculates the costs associated with the collection, testing, storage, distribution, delivery, and transfusion of blood in Greece. Section 2 outlines the methodology used in data collection. Section 3 presents the results, whereas Section 4 discusses the policy implications that arise and draws the main conclusions.

METHODS

A national system responsible for the collection and cross-checking of blood, as is the case elsewhere (49), does not exist in Greece, despite the existence of a national blood coordinating policy (31). Instead, blood collection is delegated to several public hospitals dispersed throughout the country. Of these, two public Blood Centers were selected, one in Athens (Athens 3rd Regional Blood Transfusion Centre, henceforth, ABC) and one in Herakleion, Crete (henceforth HBC). Both are located in hospitals and have dual function as collectors and users of blood. Both are representative of blood centers within the Greek NHS, with ABC being a major facility and HBC being a smaller facility; they also provide the optimal combination of a centrally (ABC), and a regionally located (HBC) facility. Relevant cost data were also collected from a private hospital setting, enabling a comparison of public with private supply costs, reflecting likely differences in costs (particularly reagent) between the two sectors. The private facility selected was Hygeia hospital in Athens, and the results from this enquiry have been added for comparative purposes. The research was conducted in early- to mid-2004 and entailed direct senior management contacts at ABC and HBC, to obtain blood production and cost accounting data through requests and follow-up interviews and benchmarking with similar data collected from Hygeia hospital. All cost figures are expressed in Euros (€).

Mainly direct costs and some indirect costs were included, and intangible costs were excluded as nonapplicable or nonquantifiable with an acceptable degree of accuracy (12;13;35). Direct costs comprised advertising, blood collection and testing, storage of collected and tested blood, and blood transfusion costs on an outpatient basis.

In the absence of advertising cost data from public authorities (Ministry of Health), the cost of advertising was estimated through interviews with four leading advertising firms in Athens. In determining the total average cost of an advertising spot, the cost of producing a TV spot and the monthly cost of TV running time were established. Total annual advertising costs were calculated taking into account the length of the average annual advertising campaign. Unit advertising costs were obtained by dividing total advertising cost by the total number of blood units produced in Greece in 2004.

The (unit) cost of blood collection and testing comprised (i) personnel costs, such as staff salary data, employers' contributions, and statutory employee benefits; (ii) reagent costs, namely, hepatitis B surface antigen (HbsAg), hepatitis B core (HBc), hepatitis C virus (HCV), human immunodeficiency virus (HIV-1, HIV-2), hepatitis B virus (HBV), syphilis, immunoglobulin M HBc (IgM HBc), and nucleic acid testing (NAT), both in the two public hospitals and the private Hygeia hospital; and (iii) equipment costs, including the cost of equipment used, maintenance, and depreciation for laboratory equipment and vehicles, on the basis of accelerated depreciation (5 years).

Blood storage costs included personnel and equipment costs from both blood centers. Equipment costs comprised operating, maintenance, and recovery costs of storage and deep freezers. It was expected that unit costs would be similar across ABC and HBC due to the similarities displayed (identical electricity prices, similar capacity, already depreciated cost of equipment).

Blood transfusion cost, included staff costs (doctors and blood technicians), transportation to the transfusion facility (assuming that 60 percent of blood collected in both centers would be transported for use in other hospitals), maintenance, and hospitalization costs resulting from an extended length of stay in 2 percent of cases, due to complications or postponement of transfusion due to shortages. Transportation costs were calculated on the assumption that blood would be transported to an average 25-km radius from either ABC or HBC. The special requirements for transporting blood safely were also taken into account. Transportation comprises both personnel (a person employed at 75 percent of full-time equivalent annually) and equipment costs (a vehicle incurring costs of insurance, road tax, operating costs, and depreciation).

Indirect costs comprised blood donors' loss of productivity, assuming that each donor expends half a working day annually per unit donated. The monetary value of the half-day was based on the average salary of an employed individual across all industries reported by the Bank of Greece (3).

RESULTS

Our calculation of direct costs refers to four key cost parameters. Interviews with advertising firms established that the average cost of producing a TV spot was €30,000 (range, €28,200–€32,800), and the average monthly cost of TV running time was €165,000 (range, €158,000–€172,000). Assuming that the advertising campaign would run for 4 months per year, particularly during the summer months when blood shortages are more acute, the total average annual cost would be €690,000, or €1.15 per unit. Data from other forms of advertising campaigns (e.g., posters, leaflets, etc.) could not be disaggregated from other official public health initiatives (e.g., smoking cessation, accident prevention, alcohol abuse) and, therefore, were excluded.

The cost of blood collection, testing, processing, storage, and distribution included personnel, reagent, and material costs. The evidence is shown in Table 1 for each of the two blood centers. The differences in reagent costs per unit reflect regional differences in testing. Since the beginning of 2003, large blood centers in Greece (including ABC but not HBC) have implemented HIV-RNA and HCV-RNA by NAT–transcription-mediated amplification testing in single blood donations, while HCV-RNA in mini pools (25 units) is tested by the polymerase chain reaction I test since 2000. The total direct unit cost of collected blood was €208.7 in HBC and €253.7 in ABC. In both centers, reagents accounted for the majority of the total cost, namely 65 percent (€132.8) and 72 percent (€179.1), respectively. Personnel costs were 22 percent (€49.1) and 14 percent (€39.9), respectively. Material costs represented 13 percent (€26.8) and 14 percent (€34.7), respectively, of the total cost.

The higher personnel cost at HBC was expected, as the hospital runs an outreach station for blood collection in all parts of Crete. It can also be explained by the fact that ABC collects and processes more blood units per capita; therefore, this finding may reflect economies of scale. Overall, the total costs are comparable given that both blood centers are public and their costs are subject to the same input prices (personnel, materials, and so on).

The third cost component is that incurred by the hospital receiving the blood from the blood bank, in terms of cost of cross-matching, maintenance, transportation, and storage. This cost averaged €9.88 per blood unit for tests, rent, medical personnel, administration, auxiliary staff, and storage.

The cost of transfusion includes staff costs, transportation, maintenance, and a cost due to an extended length of stay for 2 percent of transfusion cases. This component was calculated to be €33 per blood unit transfused.

The indirect cost based on a donor's half-day off-work to donate blood was calculated to be €42.1, based on an annual salary of €20,202 (3). No indirect costs incurred by transfused patients were accounted for.

Table 2 summarizes the findings of this study. The total cost of transfusion per blood unit was found to be €294.83 at HBC and as much as €339.83 at ABC. For comparative purposes, we also included reagent costs obtained from the private Hygeia setting and based on the cost of virological testing performed routinely for in- and outpatients. These calculations would elevate the previous figures to €413.93 per blood unit.

Table 1. Direct Costs Incurred by Two Blood Centers[a] in €, 2004: Cost per Blood Unit Collected

	Herakleion Blood Centre (HBC)[b]		Athens Blood Centre (ABC)[c]	
Cost item	€ per unit	%	€ per unit	%
Personnel[d]	49.1	22%	39.9	14%
Medical	19.64		17.12	
Nursing	13.75		12.77	
Technicians	10.31		8.63	
Other[e]	5.4		1.37	
Reagents	132.99	65%	179.1	72%
Materials	26.8	13%	34.7	14%
Total cost	€208.7	100%	€253.7	100%

[a] Capital investment, building or depreciation costs have not been taken into account.
[b] HBC produced 17,000 blood units in 2004.
[c] ABC produced 35,000 blood units in 2004.
[d] These figures include blood collection, blood testing, maintenance, and storage.
[e] This line item relates mainly to staff (nonmedical) costs of the outreach unit at HBC; it also relates to the staff (nonmedical) costs of transporting blood from HBC and ABC to other facilities.

DISCUSSION, HEALTH POLICY IMPLICATIONS, AND CONCLUSIONS

Overall, the study finds that costs associated with the production and transfusion of blood are quite significant and vary across settings or type of transfusion. This finding leads to the conclusion that blood and its handling result in considerable expense to the healthcare system. The fragmented system of collecting, testing, and distributing blood in Greece, suggests that a uniform approach in obtaining cost estimates at national level is not possible. As public hospitals face near-uniform prices at the national level for personnel remuneration, reagents, consumables, and drugs (through national tenders), increasing the sample size would not enhance the quality of information obtained. Differences in cost per unit reflect differences in collection as well as regional variability in testing.

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Table 2. Total Unit Cost of Transfusion per Blood Unit in Greece: 2 Public and 1 Private Hospital, 2004 in €

Cost item	Herakleion Blood Centre (HBC)—Unit cost (€)	Athens Blood Centre (ABC)—Unit cost (€)	Private hospital unit cost (€)
Cost of advertising campaign	1.15	1.15	1.15
Cost incurred by blood center	208.70	253.70	327.8[a]
Cost of cross-matching and storage at a destination facility[b]	9.88		9.88
Cost of blood transfusion[c]	33.00		33.00
Indirect cost incurred by donor	42.10	42.10	42.10
Total	294.83	339.83	413.93

[a] On a hypothetical basis, the cost of donor blood per unit in a private establishment has been calculated based on viral marker screening of patient blood: HbsAg = €32.38; anti-HBc = €32.38; anti-HCV = €36.74; anti-HIV-1 + anti-HIV-2 = €66.94; syphilis = €62.27; NAT = €24; HBV = €34.56; IgM anti-HBc = €37.98. The NAT test was used selectively in large hospitals but has recently (April 2006) become compulsory across the country by ministerial order. Cost estimates for the NAT test may also vary depending on procurement agreements. Recent data, for example, elevate the cost per test to €100 (Laiko Hospital, personal communication, April 2006).
[b] The cost of cross-matching includes €3.51 administration costs, €2.31 auxiliary staff costs, €1.70 for tests (only cross-matching and blood type at this stage), €1.70 for medical personnel involved, €0.34 rents, and €0.32 various other costs including consumables. All figures are per unit of blood.
[c] The cost of blood transfusion includes €25.20 staff costs, €6.23 for extending the length of stay for 2% of all transfusion cases, €1.46 as transportation costs to other facilities for 60% of blood units produced, and €0.11 for maintenance. All figures are per unit of blood.
HbsAg, hepatitis B surface antigen; HBc, hepatitis B core; HCV, hepatitis C virus; HIV, human immunodeficiency virus; HBV, hepatitis B virus; IgM HBc, immunoglobulin M HBc; NAT, nucleic acid test.

The findings are consistent with those of other national studies (2;16;18;22;27;43;48;51). Studies have also confirmed the high blood costs in chemotherapy (9;36;53), surgery (5), trauma (24) and in estimating the cost-effectiveness of screening for certain viruses in donated blood (25;42;44).

The high cost of blood transfusions has important implications for health policy. First, it is paramount that policies, including clinical guidance, are in place to ensure that this scarce resource is used rationally and that waste is minimized. Second, captive donorship, still accounting for over half of the total blood supply in Greece, and its relation to blood safety and the total cost of screening and testing needs to be re-visited, as there is an increased likelihood for captive donors to be seropositive. Regular donors, therefore, are preferable to captive donors. Despite the recent surge in volunteer donorship, clearly, the practice needs to be encouraged further. This encouragement may also lead to a decline in the overall costs of blood and donor screening. Third, the high cost of blood as well as the risks associated with transfusions, make therapies alternative to hemotherapy potentially attractive. Policy makers need to consider where this is possible and also work on clinical practice guidelines on blood use or its alternatives.

In conducting this research, several methodological challenges were encountered and addressed. First, a difference exists between public (NHS) and private sector prices, as the former are capped through regulation (e.g., physician salaries) or national tenders (e.g., supplies and reagents), and the latter are governed by market principles. Considering the cost of blood transfusion in a private facility highlighted this division. Second, the cost of production of blood banks may vary due to differences in productivity, the supply of donors, demand from health services, and socioeconomic factors. This variation was addressed by selecting a sample of Blood Banks/hospitals that reflected these differences. Third, we assumed that collected blood was subjected to uniform testing throughout the country for all major infectious diseases, although differences exist in the intensity and type of testing across regions. Fourth, although the literature suggests that overall transfusion costs may vary depending on whether they are autologous or allogenic, it was assumed that 100 percent of blood transfusions in Greece are allogenic, based on the expert opinion of hematologists. Yet, although the literature suggests cost equivalence, *ceteris paribus*, between the two in view of modern blood banking techniques (10), in practice, allogenic blood transfusion is associated with direct costs and an increase in the length of hospital stay (14), or higher incremental hospital costs, compared with autologous transfusion (5). Fifth, transfusion costs vary depending on the setting, that is, whether inpatient or outpatient: in the absence of inpatient/outpatient split, the input costs of transfusion were considered and excluded the "bed" cost element. Sixth, incidence of adverse reactions and costing depends on (i) diagnosis/reporting by clinicians and (ii) the hemovigilance system being in place. Although the risk from adverse reactions and infections is positive, sufficient evidence from Greece is not available to express the likely costs as a proportion of the total costs of blood transfusion. On account of these limitations, our calculations may be underestimates of the cost of blood collection and transfusion in Greece.

The study is not without limitations. First, the entire physical and human infrastructure (facilities, buildings, and experts) used in blood collection, testing, and transfusion activities, was taken as given, although, there are set up and maintenance costs associated with these; this includes hemovigilance, a system required in each country to ensure

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the reporting of adverse reactions and events, particularly bacteria-associated transfusion reactions, which may lead to death. Yet, such systems are costly and may deal with several thousand cases annually (32). Second, the point of departure for the study was the product of a donation, regardless of whether this donation was from a relative (captive donor), a volunteer donor, or an army recruit. However, there are *ex ante* costs of blood screening and blood donor selection procedures (37;50), further suggesting costs to human and physical infrastructure, which our study did not include. Yet, a large number of occasional captive donors, as is the case in Greece, contributes to rising overall screening costs over time. Third, the lack of data across certain cost elements meant these were excluded from the analysis, for example, the long-term costs in cases of transfusion-related disease transmission or death, and the indirect costs of transfused patients, particularly those suffering from chronic conditions.

In conclusion, blood, although a gift, is associated with significant costs to the health service to ensure its safe handling. Blood may cost less where there are coordinated collection, storage, and distribution activities at national level. Volunteer donorship is critical in ensuring (i) adequate blood supply and (ii) cost-effective production. Relying on captive donorship has been shown to be associated with higher incidence of seropositive individuals and, potentially, a higher cost of producing safe blood. Policy makers and practitioners should encourage the rational use of blood, harness wastage, build on existing policies that lead to an improved system of collection and encourage volunteer donorship; autologous donations and transfusions might offer an alternative (11;21), and so might home blood transfusions (1). Finally, where the possibility exists, alternatives to blood transfusion should be considered (7;8;26;29;30).

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