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Recombinant Human Erythropoietin vs Transfusions in the Treatment of Anemia of Prematurity: A Cost-benefit Analyis

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A Cost-benefit Analyis

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Objective: To evaluate the costs relative to the benefits of using recombinant human erythropoietin (rHuEPO) therapy as an alternative to red blood cell (RBC) transfusions in infants with anemia of prematurity.

Design: A cost-benefit analysis of rHuEPO therapy was performed based on its use in very-low-birth-weight premature infants.

Setting and Patients: Data were drawn from published studies or were provided by the University of Iowa Hospitals and Clinics, Iowa City.

Main Outcome Measures: Costs and benefits were analyzed as a comparison of incurred costs to averted costs. Incurred and averted costs of rHuEPO therapy and RBC transfusions included direct product costs and estimates of costs of adverse events. The analysis was viewed in terms of net savings. Sensitivity analysis was performed.

Results: The base case analysis yielded a net loss of $299.48 per infant. A 54% reduction in the direct product costs of rHuEPO therapy yielded a break-even point. No other variations in the sensitivity analysis resulted in a net savings.

Conclusion: Using assumptions based on the current state of clinical research, it appears that routine use of rHuEPO with supplemental RBC transfusions would not generate any cost savings as an alternative to RBC transfusions alone. As further evidence is compiled on the efficacy of rHuEPO therapy in very-low-birth-weight premature infants, the true costs may be better established.

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An estimated 38 000 infants are born prematurely each year in the United States.[1,2] Up to 30 000 will require red blood cell (RBC) transfusions for treatment of symptomatic anemia of prematurity.[2] Until recently, treatment has been limited to RBC transfusions.[3,4] However, recombinant human erythropoietin (rHuEPO) therapy has been investigated as an alternative to RBC transfusions in these infants.[5-11] Results of initial trials of rHuEPO therapy in neonates with anemia of prematurity have been mixed but promising. Resolution of symptoms, increases in bone marrow erythroid activity, blood hemoglobin, hematocrit, and reticulocytes, and reductions in RBC transfusion requirements have been reported.[5,7-12] These are outcomes comparable with those achieved using RBC transfusions.

The arrival of rHuEPO as a therapeutic alternative raises the question of relative cost vs benefit of each treatment.[13,14] As with other recent advances in pharmaceutical technology, rHuEPO has a relatively high direct product price.[13] If rHuEPO therapy proves to be equivalent or superior to RBC transfusions clinically, the potential exists for its widespread adoption. It is important to identify which option is more effective before rHuEPO becomes widely used.

To our knowledge, only one neonatal study has addressed the costs of rHuEPO therapy vs RBC transfusions.[10]

See Methods on next page

METHODS

The use of rHuEPO remains investigational. Therefore, data for this cost-benefit analysis were drawn from studies related to its use. Other data were provided by the University of Iowa Hospitals and Clinics (UIHC), Iowa City, a tertiary care center participating in an ongoing multicenter clinical trial of rHuEPO therapy in premature infants. These data included RBC transfusion requirements and hospital charges for a sample of 52 very-low-birth-weight (VLBW) premature infants (<1500 g) born between July 1991 and January 1992.

The methods for this cost-benefit analysis included the following steps: development of a relative measure of costs and benefits of rHuEPO therapy, determination of the direct product costs and costs of adverse events associated with RBC transfusions, determination of the direct product costs and costs of adverse events of rHuEPO therapy, selection of base case values for the cost-benefit analysis, selection of the variables for the sensitivity analysis, and presentation of the results. This analysis used a societal perspective and includes all medical resource costs.

Two types of cost-to-charge ratios were provided with the UIHC charge data. They were traditional cost-to-charge ratios and allowed cost-to-charge ratios.

Traditional cost-to-charge ratios reflected weights assigned to each department on the basis of its proportion of UIHC's costs. Each department divided its allotted costs among the goods or services it provided. The allowed cost-to-charge ratio reflected the costs associated with the appropriate diagnosis-related grouping. Allowed costs were used in the base case whereas traditional costs were tested in the sensitivity analysis.

MEASUREMENT OF COSTS AND BENEFITS

Costs and benefits were analyzed as a comparison of incurred costs to averted costs.[15] Incurred costs included the cost of rHuEPO per neonate plus the cost of any RBC transfusions required by the neonate while receiving rHuEPO. Averted costs were the costs of RBC transfusions avoided by the use of rHuEPO. Incurred and averted costs of rHuEPO therapy and RBC transfusions included direct product costs and estimates of costs of adverse events. If averted costs exceeded incurred costs, the difference between their total costs represented a net savings achieved by using rHuEPO. If averted costs were less than incurred costs, the difference was a net cost.

This analysis was also viewed in terms of cost-benefit ratios. The cost-benefit ratio portrayed the relative magnitude of costs to benefits. If the ratio exceeded 1, costs outweighed benefits by that multiple. Likewise, for ratios less than 1, costs fell below benefits by that relative magnitude.

VARIABLES FOR THE BASE CASE ANALYSIS

Incurred costs included the costs of rHuEPO for all treated infants and the costs of RBC transfusions that were required in addition to the rHuEPO. The RBC transfusion costs were determined by the number of aliquots and donors required, the cumulative probability of adverse events, the costs per adverse event, and the direct product costs. The dosing variables for rHuEPO came from a recently published clinical trial.[11] Subcutaneous doses of rHuEPO were administered 3 days per week for 6 weeks. Over the course of a 6-week therapy, each neonate would use 18 vials of rHuEPO for an allowed cost of $555.30 per infant.

Direct product costs of RBC transfusions were determined by the number of donors (units) the aliquots were drawn from and the number of aliquots given, based on the sample of 52 VLBW neonates from the UIHC. The numbers of aliquots and donors incurred depended on the efficacy of rHuEPO therapy and the transfusion practice of the prescribers. The UIHC data indicated that premature infants who were not treated with rHuEPO and who were transfused with erythrocytes received a median of six aliquots from three donors. The baseline assumption of rHuEPO efficacy was that 25% of these donors (0.75 donors) and aliquots (1.5 aliquots) would still be incurred when rHuEPO was used.[11]

The probability of acquiring each type of infection was calculated using the national estimates and the binomial probability function.[16] The probability of acquiring an infection from one of 1.5 aliquots incurred was multiplied by the cost per adverse event and summed across the three types of infections. These costs were added to the direct product costs of rHuEPO therapy and RBC transfusions to get total incurred costs.

Averted costs included all costs associated with averted RBC transfusions. The initial case assumed that 75% of the donors (2.25 donors) and aliquots (4.5 aliquots) were averted when rHuEPO was used. Direct product costs and costs of adverse events were computed the same way as incurred RBC transfusion costs.

TRANSFUSION COSTS

Direct Product Costs

The costs of RBC transfusions were those associated with the acquisition, preparation, and administration of the blood products and those of adverse events. It was assumed that physician, nursing, and allied health care professional costs were identical between infants treated with rHuEPO and infants treated with RBC transfusions. Similarly, room and boarding costs were excluded because the length of stay between treatment groups was not shown to be significantly different.[11] Direct product costs were based on charges from the UIHC. Charges related to the RBC transfusions were determined from the billings of the infants who had received RBC transfusions (1991 dollars). The itemized charges recorded in the hospital bill reflected a summing of the various direct costs into one figure. Therefore, delineating the actual number of units of each cost was not

Continued on next page

possible with the data provided. As a best estimate, the itemized charges for blood products were multiplied by their corresponding cost-to-charge ratios to give the cost by department.[17,18]

Based on the itemized bills, transfusion costs consisted of costs incurred in the blood donor center (allowed cost-to-charge ratio, 0.75643) and a minimal charge for the intravenous tubing (allowed cost-to-charge ratio, 0.59323) used to infuse the blood. These charges are listed in **Table 1**. Charges were categorized as donor related and aliquot related. Donor-related charges were incurred for a single unit of blood from a single donor. Aliquot-related charges represented a single RBC transfusion that was drawn from a single unit. Several aliquots of blood may have been withdrawn from a single unit of blood.

If multiple aliquots for the same infant were taken from the same unit, the costs of irradiation, cytomegalovirus (CMV) screening, and blood product aliquot were not duplicated. To determine the direct costs for each infant, the number of aliquots received was multiplied by the administration and processing cost and the intravenous tubing cost or the total for aliquot-related costs. Irradiation costs, CMV-screening costs, and blood product aliquot costs, which were the total donor-related costs, were multiplied by the number of donors for each infant. The direct cost per infant was a sum of the aliquot- and donor-related costs. For instance, if an infant received two RBC transfusions (or aliquots) that were taken from a single donor, the direct cost would be $49.73+(2)($47.49)=$144.71.

Costs of Adverse Events

The use of RBC transfusions carries numerous risks. These risks increase as the number of transfusions increases, especially when the RBCs are obtained from different donors.[3,4] Potential blood-borne infections are associated with viral pathogens that include hepatitis C, hepatitis B, human immunodeficiency virus (HIV), and CMV.[3,4,12,19] These may be fatal or may precipitate serious morbidity in premature infants.

Estimates of the costs of adverse events were taken from the published cost of illness studies, except for CMV infection. All estimates were inflated to 1991 dollars using the medical price index.[20] Although the rate of infection is somewhat controversial, the use of blood that tests negative for antibodies to CMV in seronegative neonates has virtually eliminated RBC transfusion-acquired CMV infection when such precautions are used.[21] Therefore, costs were not measured for transfusion-acquired CMV infection.

The value used for the cost of treatment of hepatitis C reflected an estimate of direct and indirect costs of adult treatment discounted over a 15-year period at an unspecified rate.[22] The midrange estimate from that study was $5544 in 1991 dollars. This estimate excluded newer forms of treatment such as transplantation and use of interferon but did include work-loss costs and the cost of premature death. The hepatitis B estimate ($22 428 in 1991 dollars) was specific for newborns and was based on direct medical care costs that were only discounted at 5% per annum over 30 years.[23]

Few studies have been published on the costs of treating children who are HIV seropositive or who have acquired immunodeficiency syndrome (AIDS). A retrospective chart review examined the economic costs of 37 children who were treated as inpatients for AIDS or AIDS-related conditions.[24] The lifetime cost estimate for the medical costs ($87 464 in 1991 dollars) was not discounted. This figure excluded advances in treatment, especially for pharmaceuticals. Because infants who contract HIV infection as neonates usually survive for less than 6 years, long-term work-loss costs were not included.[25]

The final estimation of the costs of adverse events from RBC transfusions was a function of the probability of occurrence and the medical costs for treating each adverse event. The rates for each type of transfusion-acquired infection were 0.03% for hepatitis C, 0.0005% for hepatitis B, and 0.00044% for HIV infection.[26-28] The national estimates for infections implied that these pathogens are randomly distributed in the blood supply. Locally specific rates for transfusion-acquired infections may vary considerably, especially in areas with higher rates of donor infections. Cumulative probability estimates for the number of aliquots (RBC transfusions) incurred and averted were computed using the binomial probability function.[16]

These estimates did not include all the potential costs that are associated with RBC transfusions. Other adverse events that could be assessed are associated with development and treatment of hemolysis, hyperkalemia, and graft-vs-host disease secondary to RBC transfusions.[29] Indirect and intangible costs include time and productivity losses for the parents and the donor and pain and suffering. For compensated blood donors, the time and productivity loss costs were assumed to be accounted for in the charges for blood products. Similar costs for voluntary donors were not included. One could argue that volunteers are compensated for their losses through nonmonetary values. By not incorporating these costs explicitly, the cost estimate for RBC transfusions may be underestimated. Transfusions in premature infants can precipitate considerable mental strain for parents and relatives. Although this anguish cannot be quantified readily, it should affect decisions concerning treatment options.

However, those authors did not address costs associated with adverse events. The potential blood-borne infections transmitted by RBC transfusions carry considerable costs. These costs may be even higher in infants because of the significant number of RBC transfusions they may receive and the lifelong effects of these adverse events. Because the effectiveness of either therapy appears to be comparable in terms of

COSTS OF rHuEPO THERAPY PLUS RBC TRANSFUSIONS

Direct Product Costs

Erythropoietin therapy costs included drug acquisition costs, costs of preparation and administration (including supplies), and costs of adverse events. For product acquisition costs, the entire vial cost was assessed. Doses for neonates would not require the entire contents of the smallest vial (2000 U) currently commercially available.[30] However, anopen vial was assumed to be used once and discarded per manufacturer's recommendations.

The hospital's charge per 2000-U vial was $40.14. The allowed cost for rHuEPO doses under 10 000 U was $30.85 (cost-to-charge ratio, 0.76848). These costs included preparation and administration costs. As with transfusions, professional and room costs were not included. The direct product costs for any RBC transfusions required by infants receiving rHuEPO were calculated as per the preceding section and were added to the direct cost of rHuEPO therapy.

Costs of Adverse Events

The incidence of adverse events to date with the use of rHuEPO in neonates with anemia of prematurity has been minimal to nonexistent. The most prevalent was neutropenia, which has not been associated with infections.[5,8,10] If an infection were to develop secondary to the neutropenia, its costs would have to be incorporated into the costs of rHuEPO therapy. However, because no reports have been issued, these costs were not quantified. One may speculate, however, that the probability of infections developing or other adverse events arising will increase as the population of infants who receive rHuEPO increases. For the purposes of this analysis and until future data on adverse events are collected, their costs were considered insignificant for rHuEPO therapy.

The costs of rHuEPO use also did not include iron supplementation costs. Most clinical trials suggest that iron replacement may be necessary in conjunction with rHuEPO.[5,8,11] The costs of oral iron products are relatively low, and many nurseries for premature infants are already treating all of their infants with oral iron as a medication or as a supplement to infant formula. As with the direct product costs for rHuEPO therapy, the cost of adverse events associated with RBC transfusions was included in the cost estimates for rHuEPO therapy for infants who still require RBC transfusions.

VARIABLES FOR THE SENSITIVITY ANALYSIS

The first sensitivity analysis involved substituting traditional costs for allowed costs. All others were one-way sensitivity analyses of single variables from the base case. The rationale for varying the variables in the sensitivity analysis are discussed below.

Traditional Cost-to-Charge Estimates

Traditional cost-to-charge ratios gave higher cost estimates than the allowed cost-to-charge ratios. The ratios for direct product costs of RBC transfusions increased to 0.88281 except for intravenous tubing (0.71154). The direct product cost estimate for rHuEPO used a ratio of 0.89546.

Direct Product Cost of rHuEPO

The baseline direct product cost for rHuEPO contained an estimate based on the hospital charge per dose. Even as neonates gain weight during the course of therapy, it is unlikely that they will require the entire contents of a 2000-U vial. Manufacturers may decide to prepare the product in more dilute concentrations or smaller vials suitable for infants and children. It is unclear what effect such repackaging would have on the cost of the product, but it could conceivably lower the price. To assess the impact of a reduction in price, the allowed cost estimate was decreased by 50% and 75%. The resulting costs were $15.43 and $7.71 per vial, respectively.

Dosing

The optimal dosing variables for rHuEPO in premature infants remain uncertain. Some studies included five doses per week, whereas the more recent clinical trials used three doses per week.[11,12] It is also possible that a shorter duration of therapy may be effective. To account for a potentially effective less frequent dosing or shorter duration of therapy, the use of two vials per week (equivalent to three doses per week for 4 weeks or 12 vials) was tested.

Efficacy

The base case assumption for efficacy of rHuEPO was that 75% of the RBC transfusions in terms of donors and aliquots would be averted.[11] Ideally, rHuEPO therapy would avert all RBC transfusions, although, because of frequent phlebotomy requirements in VLBW infants, this is unlikely to occur. Because the decision to transfuse is based on clinical judgment, the rate of RBC transfusions will vary by institution and practitioner.[31] Given these considerations, the bounds of efficacy for rHuEPO therapy were set at 50% and 85%. For the lower bound (50%), three aliquots and 1.5 donors would be incurred and an equal number would be averted. In the case of the 85% efficacy, five aliquots and 2.5 donors would be averted, and one aliquot and 0.5 donor would be incurred.

resolution of the symptoms, the following report details an analysis aimed at determining which is the least costly.[5,7-12] The benefits of rHuEPO therapy are principally the averted costs of reducing transfusion requirements. The objective of this analysis was to evaluate the costs relative to the benefits of using rHuEPO by incorporating the direct product costs and the costs of adverse events of RBC transfusions.

Table 1. Red Blood Cell Direct Product Transfusion Costs*

Item	Charge, $	Traditional Cost, $	Allowed Cost, $
	Donor Related		
Irradiation	31.25/U	27.59	23.64
CMV screening	10.00/U	8.83	7.56
Blood product aliquot	24.50/U	21.63	18.53
Total Donor Related	...	**58.05**	**49.73**
	Aliquot Related		
Administration and processing	62.00/ALQ	54.73	46.90
Processing IV tubing	1.00/ALQ	0.71	0.59
Total Aliquot Related	...	**55.44**	**47.49**

**Values are expressed as 1991 dollars. U indicates single unit of blood from one donor; CMV, cytomegalovirus; ALQ, single aliquot or individual transfusion; and IV, intravenous.*

Table 2. Base Case Analysis*

	Allowed Costs† per Infant	
	Incurred	**Averted**
rHuEPO costs	555.30	...
RBC costs		
Donor related	37.30	111.89
Aliquot related	71.24	213.71
Adverse events	4.79	43.55
Total Costs	**668.63**	**369.15**

**Differences in totals are due to rounding. RBC indicates red blood cell; rHuEPO, recombinant human erythropoietin.*
†Values expressed as 1991 dollars.

RESULTS

BASE CASE ANALYSIS

The base case analysis in 1991 dollars of allowed costs incurred and averted (per infant) in treating premature infants with rHuEPO is shown in **Table 2**. The cost-benefit ratio was 1.81. A net loss of $299.48 per infant would be incurred. Approximately 88% of the averted costs were direct RBC transfusion costs and the other 12% were due to adverse events. The direct product costs of rHuEPO accounted for 83% of the incurred costs.

SENSITIVITY ANALYSIS

A summary of the results of the sensitivity analyses is presented in **Table 3**.

Traditional Cost-to-Charge Ratios

With the higher traditional cost-to-charge ratios, the net loss increased to $354.77 per infant. The relative proportion of direct RBC transfusion costs averted increased slightly to 90%. Direct rHuEPO costs still accounted for 83% of incurred costs.

Direct Product Cost of rHuEPO

The amount of price reduction did have a significant impact on the cost-benefit ratio. If the allowed cost was reduced by 50%, the costs of rHuEPO therapy still would outweigh the benefits but only by a narrow margin. The net loss would be reduced to $21.91 per infant. On the other hand, if allowed costs were reduced by 75%, rHuEPO use would yield a net savings of $117.05 per infant. The break-even point occurred with approximately a 54% reduction in product cost to $14.20 per vial.

Dosing

A reduction in the number of doses required given the base case assumptions for the other variables and the allowed costs would not generate a financial savings. If 12 vials were used in the course of therapy, the net loss would fall to $114.37 per infant.

Efficacy

The final test of the assumptions was based on the efficacy of rHuEPO therapy. If 50% of the donors and aliquots could be averted, the net loss would be $555.30 per infant. Even with an 85% reduction in the number of donors and aliquots incurred, indicating a greater efficacy than in the base case, the financial cost of rHuEPO therapy would still outweigh the benefits. The net loss would be $215.99 per infant.

COMMENT

Although this analysis suggests that rHuEPO therapy would not be a cost-effective alternative to RBC transfusions in infants with anemia of prematurity, further consideration must be given to the variables tested. Across most of the range of variables tested, the costs of rHuEPO therapy exceeded the benefits. The only exception was a 54% reduction in the direct product costs of rHuEPO.

It is unlikely that such a cost reduction would be possible because those costs include direct material costs and the cost of preparation. Of course, the assumption that each 2000-U vial would be used once and discarded may be questioned. It is conceivable that more than one dose could be withdrawn from a vial for use in other premature infants undergoing therapy concurrently or for subsequent doses. Eliminating wastage would improve the cost-benefit picture as was seen in the analysis of altering the dosing variables. Reducing the usage from 18 vials per infant to 12 vials per infant changed the net loss from $299.48 to $114.37 per infant. The simultaneous treatment of two or more premature infants depends on

Table 3. Summary of Sensitivity Analyses*

Variable	Cost per Infant, $		Net Loss per Infant, $	Cost-benefit Ratio
	Incurred	Averted		
Traditional cost-to-charge ratio	778.41	423.64	354.77	1.84
rHuEPO costs				
50% reduction	391.06	369.15	21.91	1.06
75% reduction	252.10	369.15	−117.05†	0.68
Dosing (12 vials)	483.52	369.15	114.37	1.31
Efficacy				
50% of transfusions averted	865.77	310.47	555.30	2.79
85% of transfusions averted	629.82	413.83	215.99	1.52

**Values are expressed as 1991 dollars. rHuEPO indicates recombinant human erythropoietin.*
†Represents a net gain.

the probability that a given institution will have two or more infants in-house concurrently receiving rHuEPO. This is more likely in tertiary care facilities.

With a 50% reduction in direct product costs, the net loss per infant was $21.91. It is arguable that the intangible and indirect costs associated with RBC transfusions may outweigh that financial loss. Taking that argument from an individual's perspective, exposing infants to RBC transfusions may be unbearable and worth avoiding at any cost. (This same argument could be applied to all scenarios tested.) From the societal perspective, however, one would have to quantify those costs for all the infants treated.

If rHuEPO therapy is more efficacious than the baseline estimate, the net loss improves to $215.99. Ongoing clinical trials will help to determine the relative efficacy of rHuEPO therapy and may identify subgroups of neonates who may not need either RBC transfusions or rHuEPO therapy. One would have to control for the various transfusion practices at individual hospitals. The median number of donors and aliquots that VLBW premature neonates are exposed to at the UIHC may be representative of tertiary care facilities, but generalizing to community, general, or other hospitals could be problematic. The transfusion practices continue to change at the UIHC with a steady decline in exposure to donors and aliquots.[3] This decline may flatten out with or without the adoption of rHuEPO therapy.

The same holds true for the costs of the adverse events associated with RBC transfusions. As the blood supply becomes safer, the probabilities of transfusion-acquired infections fall. Consequently, their costs decline. As a countervailing effect, though, one must consider the adverse-event cost estimates used in this analysis. The estimate for hepatitis C was based on an adult population and probably underestimated the lifetime costs for infants. The hepatitis C and HIV estimates excluded newer therapies. Only the hepatitis B estimate was specific for newborns and based on more current practice. As for the exclusion of the costs of CMV infection, the assumption was that the screen was 100% effective and universally employed. Violation of any of these assumptions would increase the costs of RBC transfusions.

The results were reported on a per infant basis. There are potentially 38 000 premature infants born in a given year.[1,2] Of the 52 VLBW neonates sampled from the UIHC, 67% were transfused with RBCs. Applying this proportion to the population of VLBW premature infants yields approximately 25 500 infants eligible for rHuEPO therapy. Using the net loss in terms of allowed costs from the base case, society's medical loss would total over $7.4 million. Approximately 57 375 donor exposures and 114 750 aliquots would be avoided. In addition, 172 cases of hepatitis C would be averted. Less than one case each of HIV and hepatitis B would be eliminated.

If rHuEPO becomes approved for the treatment of anemia of prematurity, the potential exists for neonates to be treated unnecessarily. If a mechanism for determining which particular subpopulations of premature infants would benefit most from rHuEPO therapy can be found, these numbers could be significantly reduced and the cost-benefit profile could be altered. Once again, future results of clinical trials may indicate better guidelines for treatment.

The outcome measure used in this analysis was averted costs stemming from avoided transfusions. In that sense, this study was a cost-benefit analysis. An alternative assessment would be a cost-effectiveness analysis that would allow for the measurement of other types of clinical effects.[32] Ideally, a prospective study would incorporate effectiveness measures such as changes in hematocrits and more specific aspects of RBC transfusion requirements to test this assumption. Simply counting the number of RBC transfusions administered is a less than precise measure of outcome. These results would help to determine if rHuEPO therapy and RBC transfusions provide equally effective clinical outcomes.

Recombinant human erythropoietin is still in the clinical trial phase for treatment of anemia of prematu-

rity. Our analyses suggest that the manufacturer may want to consider repackaging the product in smaller dose vials and/or lowering the product price by a significant margin. Although these results are discouraging, they need not dictate the abandonment of a potentially useful product. Further evidence is needed to establish the efficacy of rHuEPO therapy in this patient population. In addition, identification of response variation in subpopulations may yield neonates who decidedly benefit more from rHuEPO therapy than from RBC transfusions or vice versa.

One cannot exclude indirect costs entirely from these analyses. The indirect costs of transfusing neonates weigh heavily on the minds of clinicians, parents, families, and others. Although this analysis was done from the societal perspective, the individual perspectives of these decision makers may lead to different conclusions.

The resources allocated to financing and providing health care have been rising rapidly. This has been driven in part by new technologies such as rHuEPO therapy. Many of these technologies are useful and cost-effective whereas others are not.[20] Economic analyses of resource allocation in health care will be increasingly important as biotechnology leads to new and expensive products.

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