Blood Components as Joint Products: A Literature Review of Cost-Allocation Methods

Alessia D’Andrea¹

¹ Department of Management, Università Politecnica Delle Marche, Ancona, Italy

Correspondence: Alessia D’Andrea, Department of Management, Università Politecnica delle Marche, Piazzale Martelli, 8-60121-Ancona, Italy. Tel: 39-071-220-7233. E-mail: a.dandrea@staff.univpm.it

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Abstract

The object of this review is to present and to shed light on joint cost-allocation methods that are used in the healthcare sector for pricing purposes or cost-effectiveness purposes in different countries. The concept of jointness is illustrated through joint products and joint costs as found in the example of blood component production. The descriptive review, fundamentally concept-centric, highlights that the cost of blood products or blood price-setting is an issue in legislative proposals at the national and state levels and represents a matter of public interest and of public regulation. In applying economic models (based on economic principles and behavior axioms) rather than accounting methodology (based on physical measures or on market value of the split/final products), scholars have brought to light the problems arising from the continuous search for a neutral method for allocating joint costs in the blood production sector. Numerous studies have focused on the blood costs for the health system. Nevertheless, the cost accounting and reimbursement system effectively underlying the acquisition, screening, and transfusion of blood appears, in practice, to be largely obscure. Moreover, the literature provides little insights into the level of “relative importance” assigned to each product in the costing setting. The current status of the discussion offers opportunities for future researches, which could be directed toward investigating the relationships between national systems of healthcare services and the cost-allocation methods used to determine the cost/price of blood components, analyzing the effect of public regulation on blood costs and, lastly, developing a method based more on the benefit-value to users.

Keywords: blood components, cost-allocation methods, healthcare system, joint products, joint costing, public interest

1. Introduction

There is a joint-cost allocation problem in matters of public interest, particularly as concerns the health and economic relevance of blood product costs (Cumming, Wallace, Surgenor, Mierzwa, & Smith, 1974; Dixon & Trenchard, 2001; Lowe, 1997; Trenchard & Dixon, 2003). Blood products mainly consist of red cells, plasma, and platelets. One raw material (whole blood) can yield these three products, using two different techniques but sharing some steps of the manufacturing processes (World Health Organization WHO , 2002).

According to the latest statistical data reported by WHO, 112.5 million blood donations are collected globally from voluntary unpaid donors (in increasing percentages of the total), from family/replacement donors, or from paid donors. This supply meets the needs of patients for transfusions required in supportive care in cardiovascular surgery, transplant surgery, massive trauma, and therapy for solid and hematological malignancies (principally in high-income countries) and to manage pregnancy-related complications and severe childhood anaemia (typically used in low- and middle-income countries) (WHO, 2016).

Over the last few decades, a number of accounting and economic analyses have been conducted, worldwide, to highlight the cost of blood components for clinical use. Each of these studies has had different aims and has adopted different perspectives and methods. Several research studies, focused on the U.S. context, accounted the cost of blood transfusions incurred by a hospital entity (Custer, Agapova, & Martinez, 2010; Forbes et al., 1991; Sullivan & Wallace, 2005; Surgenor, Wallace, Cumming, Mierzwa, & Smith, 1973; Toner et al., 2011), highlighting the acquisition cost or price paid by the hospital for a unit of blood products (principally red cells) and identifying the cost variation (by year and/or by region) in blood services. They analyzed the blood product cost from a payer's perspective: the final price charged by suppliers (non-profit or profit providers, such as the
Red Cross or blood banks) to hospitals when acquiring blood represents one of the many cost elements making up the total costs related to blood services. Another group of scholars accounted the cost of blood products and blood transfusions from a social perspective (Abram & Sun, 2012; Glengärd, Persson, & Söderman, 2005; Shander et al., 2010; Varney & Guest, 2003), including the following cost elements: cost incurred by the donor to donate blood and the opportunity cost of time spent making a donation, the cost of blood collection and processing, and the hospital services costs incurred in transfusing and follow-up activities. Finally, efforts to determine the cost of blood products were also conducted from a provider's perspective. Accounting scholars, economists, scholars in medical matters, and practitioners focused on the costs related to donor recruitments, collection, screening, processing, storage, and distribution of blood components (Cumming et al., 1974; Dixon & Trenchard, 2001; Eandi et al.; 2015; Fragoulakis, Stamoulis, Grouzi, & Maniadakis, 2014; Lowe, 1997; Mafirakureva et al., 2016; Trenchard & Dixon, 2003). They presented different insights, points of view, and objectives in investigating the cost of blood products. They determined the cost of blood unit production from a managerial perspective and/or a cost-related pricing perspective. In these views, the objectives are to develop a cost-allocation model as the basis for blood pricing or blood tariffs (in a regulated public health system) and to apply accounting, sociology, or economic theories to the complex issues of blood costs originating from joint processes.

In this matter, both accounting scholars (Bhimani, Horngren, Datar, & Rajan, 2015; Drury, 1996; Gordon, 1967; Horngren, 2011) and economists (Balachandran & Ramakrishnan, 1996; Thomas, 1974) maintain that the allocation of joint costs is arbitrary, but – at the same time – that practices of cost allocation appear to have remained in use, mainly in product costing, inventory valuation, and performance measurements.

The main objective and contribution of this paper is to review the extant literature on cost-allocation methods applied to the joint costs of producing blood components, in order to offer a synthesis of the current status of the discussion and a base for further research in this field. To this end, the paper is structured as follows. A general overview of the concepts of joint product and joint costing is discussed in the next section. Then, a technical discussion of the manufacturing process for blood components and of its cost elements further clarifies the complex problem of jointness in blood services. After this introduction, the method used for the literature review is presented. In the last two sections, the findings are presented and discussed, and the conclusions are drawn.

2. General Overview of the Joint Product and Joint Costing Concepts

This section constitutes the basis for determining the key words used for searching the literature and presents the general framework which was used for selecting the studies to be included in the review. The reader will be introduced to the concept of joint costing, along with the associated terminology, cost allocation methods, and issues that should be considered in the calculation of joint product costs. Furthermore, the background information will be useful to better understand the joint cost setting in the blood sector.

2.1 Joint Product and Joint Cost Concepts

When a common process (or series of processes) of a single input or set of inputs yields two or more products simultaneously, these products are referred to as joint products (JPs) (Bhimani et al., 2015; Gordon, 1967). There are innumerable cases of joint products in practice: examples are beef and hides from cattle, lumber and pulp from logs, coke, gas, and other goods from coal, gasoline and fuel oil from petroleum, etc. In each of these examples, no individual product can be produced without the accompanying products (Horngren, 2011). The two or more products are considered joint because there is a fixed relationship between each unit of common input and the expected output for each of the resulting products (Hemmer, 1996). According to Gordon (1967), joint processing situations are connected with fixed yields (the JP are derived in proportions which are fixed by formula); materials-determined yields (the percentage yields of each of the JP depends on the quality or composition of the joint materials inputs); processing-determined yields (the relative yields of various JPs can be varied by alteration in the processing method employed). The joint products are indistinguishable as separate products until the processing reaches a split-off point (Schneider, 1986). At this juncture in the process, one or more products become separately identifiable (Bhimani et al., 2015; Horngren, 2011). In the JP setting, the accounting literature has distinguished joint products (in the strictest sense of the word), by-products, main product and scrap. Blocker and Weltmer (1954) describe the difference between joint product and by-product as follows: “If a firm is manufacturing or processing two or more commodities from one basic raw material and if one or more of these commodities are considered of less relative importance that the others, the firm is said to be producing under by-product conditions, and the commodity or commodities of less relative importance than the others are termed by-products. However, if the products obtained are of relatively the same value, the firm is said to be operating under joint-product conditions, and the units of production are termed joint products” (p. 270).
Other scholars recognize the “level of importance” related to the sales value and identify the by-products as the outputs with minor sales values compared to joint products or the main product (defined as the only product with a relatively high sales value); in this sphere, scrap has only a minimal sales value (Bhimani et al., 2015; Drury, 1996; Gordon, 1967). The distinction presented is important in accounting for the choice of the cost allocation method adopted. As for costs, all those incurred prior to the split-off point of the JP are joint costs (JCs), while costs incurred for further processing and disposal (if completed) are separable costs since they can be assignable to one or more individual products (Bhimani et al., 2015; Schneider, 1986). Before the split-off point, costs cannot be traced to each JP; instead, at or after the split-off point, costs for each identifiable product could be easily defined and each output could be the object of separate decisions for selling or for further processing (Drury, 1996). In all joint production processes (beyond the relative importance assigned to different products), the attention to the JC setting focuses on the allocation of costs to the JP and the uses of the allocation in output decisions (Biddle & Steinberg, 1984). The allocation of JCs to individual products supports managerial decisions in several contexts. Three main purposes of the literature in this field (Bhimani et al., 2005; Biddle & Steinberg, 1984; Blocker & Welmer, 1954; Drury, 1996; Gordon, 1967; Horngren, 2011) can be discerned:

- Price-setting purposes (calculating the profit-maximizing output levels, the selling prices, the rate or price regulation; defining the cost reimbursement for companies under cost-plus contracts with a government agency);
- Internal reporting purposes (analyzing divisional profitability, evaluating division managers’ performance, addressing the stock evaluation);
- Financial accounting and tax reporting purposes (calculating ending inventory values, providing a cost-based analysis of the loss in value in insurance-settlement computations for damage claims related to JPs).

2.2 Cost allocation Methods and Boundaries Issues

The principal problem in accounting for joint products is determining the proportionate share of the total cost of production up to the split-off point that should be allocated to different products originating in the manufacturing process (Blocker & Weltmer, 1954). In addressing the calculation of the full costs of JPs, the cost accounting literature has developed two different approaches that can be used to apportion joint cost up to the split-off point, based on physical measures (weight, volume, etc.) or on the market value of the products (Bhimani et. al, 2015; Blocker & Weltmer, 1954; Drury, 1996; Gordon, 1967; Horngren, 2011; Schneider, 1986). The first approach, or physical measure-based method, allocates the JCs by apportioning the costs in proportion to volume, to weight, to quantity, or to other physical measures of the total production of each product. This method assumes that each output has no relationship to the ability of each product to generate revenues. The second approach can be adopted using three different methods:

- The sales value at the split-off;
- The estimated net realizable value (NRV);
- The constant gross-margin percentage NRV.

Using the sales value at the split-off method, the JCs are allocated in proportion to the estimated sales value of production (at the split-off point) on the assumption that higher selling prices indicate higher costs. The application of this method assumes that all products could sell at the split-off point; if, instead, one or more of the split products are processed beyond this point, a market value may not exist for the product at this stage. In this case, the estimated NRV method is typically preferred to the sales value method. The NRV method allocates the JCs proportionally to the net realizable values (selling prices of the final products minus the expected separable costs of production and marketing of the total production of the period) of the JPs. Applying the NRV method, the gross profit percentages are different for each product. The constant gross-margin percentage NRV method allows the allocation of JCs so that each final output achieves an identical gross-margin percentage. Its calculation requires three discrete steps: 1) compute the overall gross-margin percentage (by deducting the total cost of all products from the total sales of all products and expressing the profit as a percentage of sales); 2) apply the overall gross-margin percentage to the total sales of each product and deduct the result from the total sales of each product to obtain the total costs that each product should bear; 3) deduct the separable costs of each product from the total cost (resulting from step two) to calculate the share of JCs for each final product. This method assumes that the relationship between cost and sales value (for each final output) is uniform.

On a different basis, the cost accounting literature has proposed methods to allocate JCs when one or more of the split products are by-products (Bhimani et. al, 2015; Blocker & Weltmer, 1954; Drury, 1996; Gordon, 1967; Horngren, 2011; Marshall & Drobrowski, 2003). As stated by Drury (1996), “by-products are products that have a minor sales value and that emerge incidentally from the production of major products” (p. 184). Although
different variances are proposed in practice, the cost allocation method (called by-product method) consists of
crediting a process with the sales value of the by-products either at the time of production or at the time of sale
and dividing the residual among the main products. There are two basic methods of accounting for by-products:
the production method (the by-product is recognized in the financial statement at the time production is
completed) and the sales method (the by-product is recognized at the time of sale). With these two accounting
approaches and the basic choice of whether to consider (in the income statement) the by-product revenues as a
cost reduction of the main or joint products or as a separate item of revenue (or other income), different versions
have been developed, in practice, for valuating by-product inventories on the corporate balance sheet.
Considering that “in the joint-cost setting, it is not feasible to use the cause-and-effect criterion to guide
individual product-cost allocation” (Bhimani et al., 2015, p. 155), a possible discussion concerning the effects of
the application of the earlier methods can be proposed, considering the benefit-received criteria for
cost-allocation. The physical measure-based method hypothesizes that a split product has no relationship to its
revenue-producing ability: therefore, when using the benefit-received criterion sales-based methods are preferred
(Horngren, 2011; Bhimani et al., 2015).

The search for neutral allocations has led other researchers to consider approaches based on economic principles
and behavior axioms, in order to find allocation methods able to reflect the “true” relationship between a given
indirect cost (JC) and its cost objective (JP). On this matter, Thomas (1969, 1974) argued that the principle of
economics could be invoked in defense of an allocation method. The economic approach (Balachandran &
Ramakrishnan, 1996) might be traced back to those studies in which the mathematical approach (with linear and
nonlinear programming frameworks) and the duality theory for optimal allocation are used (see, Kaplan, 1982;
Kaplan & Thomson, 1971; Kaplan & Welam, 1974; Manes, 1982) and to those which present a set of axioms or
objectives that allocation methods and models should possess and provide models to achieve these objectives
(Jensen, 1977; Louderback, 1976; Moriarity, 1975, 1976). Considering the two different approaches, several
scholars later proposed models based on the game theory concept (Balachandran & Ramakrishnan, 1981;
Hamlen, Hamlen Jr, & Tschirhart, 1980; Hughes & Scheiner, 1980), on the multiple agent setting, and the
principal-agent framework (Balachandran & Ramakrishnan, 1996; Hemmer, 1996; Zimmerman, 1979), to name
but a few. Among these models, Balachandran and Ramakrishnan (1981,1996) propose the two-phase model,
which combines Moriarity’s model (Moriarity, 1975; 1976) and Louderback’s model (Louderback, 1976),
overcoming the limitations of the two previous ones.

Moreover, in the accounting and economic literature, the activity-based costing (ABC) criteria may be used in
allocating overheads to the production process activities (Cooper & Kaplan, 1988; Kaplan & Atkinson, 2015).
Several scholars adopt the ABC perspective in order to determine the allocation drivers of JC to JPs (Dixon &
Trenchard, 2001; Trenchard & Dixon, 2003; Tsai, 1996; Tsai et al., 2008). In this respect, Bromwich and Hong
(1999) highlight significant criticisms about the application of ABC methodology on jointness situation. the
authors, indeed, affirm that “Non-jointness is only one condition necessary to allow independent cost functions
to be formed for each cost pool.” (p. 46).

3. Technical Overview of the Blood Manufacturing Process

Before describing the literature review process, a brief explanation of blood products as joint products is offered
here. The blood components are prepared by centrifugation of one unit of whole blood or collected by apheresis
procedure from blood donors. By centrifuging whole blood, one unit of red cells, one unit of fresh frozen plasma,
and one unit of buffy coat (for platelet production) are obtained. By apheresis, a single component or multiple
components are collected directly from the donor, and the rest of the blood components are returned to the donor
(Basu & Kulkarni, 2014). With this technique (EU Recommendation No. R (95) 15; WHO, 2002), the most
important components that can be collected are: a double unit of red cells, one unit of platelets and one of red
cells, one unit of platelets and one of plasma, one unit of red cells and one unit of plasma, or a single unit of
plasma). The blood products derived from whole blood collection are JPs because a single input (whole blood)
yields three products simultaneously, after the centrifugation process. Each of these products (red cells, fresh
frozen plasma, and buffy coat) can be produced by the same process; a chemical and technical formula fixes the
proportion (see, for example, Recommendation E.U. R (95)15; WHO, 2002). The split-off point occurs at the
end of the centrifugation. Therefore, donor recruitment, blood collection, processing, and (most often) laboratory
tests are all steps of the joint production process to obtain JP (Toner et al., 2011). The blood products derived by
apheresis procedures are also JPs, because the products (most commonly, two: plasma/platelets, red
cells/platelets, or red cells/plasma) are collected from a single donor. The split-off point, in this case, is at the
collecting phase and the joint production involves only donor recruitment and the first step of the collecting
process. In this process, too, the apheresis collection respects specific proportions between the products (by
formula) in compliance with the industry rules and regulations. Both methods aim to provide red cells, plasma, and platelets. Plasma can be either source or recovered; recovered plasma is produced by separating donated whole blood into cellular components and plasma, whereas source plasma is collected through apheresis (Laub, Baurin, Timmerman, Branckaert, & Strengers, 2010). The plasma (both source and recovered) is fractionated by pharmaceutical industries (De Angelis & Breda, 2013) to obtain plasma-derived medicinal products. One unit of platelets is obtained directly by apheresis procedures or is buffy-coat-derived, through a pooling process which works five-to-six buffy coats (Gulliksson, 2012). The techniques used to obtain buffy-coat-derived platelets were developed in the 1990s (Murphy, 2005). After the split-off point, the final processes for each of the blood products are storage and distribution for clinical use (Schotnitzer, 2005). Before being assigned for transfusion, blood products can be adapted or treated according to their intended therapeutic use; examples of subsequent manufacturing process are: leucodepletion irradiation, filtration (Basu & Kulkarni, 2014). The production process for blood components for clinical use follows a two-step process: one associated with the blood component preparation and one connected with transfusion services (Participants of the Charleston, 2005). The manufacturing process – characterized by joint production – is developed in the first step through the following main activities: donor recruitment, whole blood collection or collection by apheresis, blood processing, testing, tracking, blood destruction and associate notifications, inventory management, storage and (if required) transportation to the transfusion site (Participants of the Charleston, 2005; Schotnitzer, 2005). The activities related to transfusion services are linked to inventory management inside hospitals, pre-transfusion preparation, administration, short-term follow-up, and long-term outcome tracking (Participants of the Charleston, 2005).

Both direct and indirect cost elements (for example, for personnel, screening, information system, equipment, materials, maintenance), are associated with each of these activities. Focusing the attention on the manufacturing phase, the costs associated with the activities before the split-off point (centrifugation of whole blood to obtain blood products; collection of blood products by apheresis) are JCs, regardless of whether the costs associated with the subsequent processing – including storage and distribution – are separable costs. Therefore, as stated by Cumming et al. (1974), “The costing problem would be confined to one of assigning all costs associated with bringing whole blood to the point of separation to various components produced: these costs are common to all final outputs” (p. 753).

4. Research Method

The following paragraphs discuss the methods used in gathering and analyzing the existing literature. In the accounting and economic research field, there are several different types of reviews (Cooper, 1998; Hopper & Powell, 1985; Webster & Watson, 2002). The present study proposes a descriptive review that is fundamentally concept-centric (Webster & Watson, 2002; p. xvi). Fink (2010) proposed four steps for a systematic review, enriching the structure proposed by Tranfield, Denyer, and Smart (2003). In the first step, the research questions are better defined: “What cost-allocation methods are used in defining blood product costs?” and “What is the understanding of blood products as joint products?”

Subsequently, the keywords “cost of blood”, “joint costing of blood”, “blood cost-allocation method”, “jointness in transfusion” and “cost of production in blood sector”, as phrases, were then defined. These keywords were selected in order to narrow the scope of the publications to those contributions strictly related to the JC discourse in the sphere of blood product costs. They were used to select which papers to examine. The databases searched were those provided by major publishers (Elsevier, Emerald, Springer, Witley) and, as suggested by Tranfield et al. (2003), not only bibliographic databases were considered. By including Google Scholar, it was possible to consider other journal publications, conference papers, and scientific reports. Using the search phrases mentioned above, the full text of the documents was extracted. In order to avoid a language bias or a preference for a specific language, only documents written in English were taken into consideration for the examination. The present literature review includes empirical publications as well as conceptual/theoretical publications (Atkinson et al., 1997). Moreover, in order to offer a complete picture of the state-of-the-art in this field, quality criteria (such as journal ranking) were not used for exclusion purposes. Publications which only mentioned the cost of the blood products, without discussing the cost-allocation methods applied, were excluded. In this group, the main research studies were framed in a social perspective or the payer’s perspective.

In order to offer a comprehensive overview, the extracted elements of interest are classified into the following categories: context of the study, typology of the research, object of the study, cost-allocation methods. In particular, the context of the study guides the discussion underlining the differences between the blood services setting in different countries and the object of the study shows whether there is a jointness problem. The classification as theoretical studies versus empirical studies makes it possible to distinguish the studies based on frameworks that aim to explain the nature of the relationship between joint costs and cost-allocation methods
(theoretical) from the studies that empirically test one cost-allocation method proposed in theoretical studies or studies that examine how blood providers approach joint costing in practice. Table 1 shows the results of the analysis.

Table 1. The analyzed literature on the JC of blood components

<table>
<thead>
<tr>
<th>References</th>
<th>Context of the study</th>
<th>Typology of the research (on JPs)</th>
<th>Object of the study</th>
<th>Cost-allocation method</th>
</tr>
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5. Findings and Discussion

An in-depth analysis of the articles included in the literature review underlines, firstly, that understanding blood product costs is useful for two main purposes or areas of application: (1) in price-setting and in reimbursement of healthcare providers; (2) in supporting public administration to increase efficiency, both in the use of blood resources and in providing health services to patients. Worldwide, in the blood services sector, providers may be public or private organizations that collect, process, and provide blood components (De Angelis & Breda, 2013). The different settings for blood supplying represent the starting point for a proper understanding of the instrumental role played by costing information for decision makers.

Cumming et al. (1974) were among the first to offer insights on blood costs. They developed an analysis of the effects of different cost accounting methods commonly used in pricing policies in the attempt to develop a rational pricing procedure which would maximize public and patient welfare in the U.S., where private blood
banks (both profit and non-profit organizations) supply blood components for transfusion procedures in hospitals. As affirmed by Cumming et al. (1974), in the U.S., blood bankers “must be ready to explain the economics of blood center operations to the public” (p. 743). Starting from the acknowledgement of blood costs as a joint cost issue, they affirmed “there cannot be a unique or “true” cost on which to base blood service prices. Every price, whether or not it is based on cost, is arbitrary and other consideration should enter into the choice of method” (p. 749) Using empirical data, they demonstrated that the most common pricing policy is based on the average cost of all units produced and the price is the same for every transfusable unit. However, these authors recognize that this method will “result in disproportionately large charges to the relatively small group of high volume or long-term users of blood services” (p. 753). In the attempt to offer a more equitable basis for price-setting in this area, they proposed three different cost-allocation methods of joint costs per single unit. The first, the red cells/market method, calculates the price of red cells (and whole blood) by subtracting the total price-setting in this area, they proposed three different cost-allocation methods of joint costs per single unit. The second, the weighted cost-price method advocated by the American National Red Cross, is based on the existence of an ideal relationship among the prices of various products. This relationship should be reflected in selected weights, used as the basis for cost-allocation. The third, the patient unit method, estimates the number of patients expected to be served by a particular combination of products. This per-patient fee is determined by dividing the forecasted total operating costs by this number. The authors highlight that the red cells/market method provides an economic incentive to use components, the weighted cost-price method leads to higher component prices and does not satisfy the need to make products available at low prices to chronic dependents, while the patient unit methods provides no incentives for efficient use of limited community blood resources.

A similar purpose guides the studies of authors Trenchard and Dixon (2001; 2003) in the UK context, where a cost problem existed (at the time of their research) within the not-for-profit blood products manufacturing sector and was compounded by the legal requirement for cost-based transfer pricing (Trenchard & Dixon, 2003). The need to contribute to this field came in the wake of the introduction of a national blood product pricing policy for England by the National Blood Authority (NBA), a not-for-profit part of the NHS (National Health Service) internal market. In their first work (Dixon & Trenchard, 2001), the authors contributed to the debate surrounding the national cost-based joint blood product pricing policy which was built upon the ABC method and implemented by the NBA in 1999. Starting with the dysfunctional nature of this kind of approach, also discussed in the literature (Bromwich & Hong, 1999), Trenchard and Dixon proposed an optimal joint-cost allocation method based on a combination of quality associated operations-based drivers, used in both the ABC and the NVR methods. In particular, their work “evaluates joint product specification elements in terms of their external quality/benefit at the point of use, rather than their internal financial benefit at the split-off point and point of sale. This reinforces the concept that the benefits provided by products are the ultimate cost drivers and from an ABC-like perspective, REV is regarded as a value-based cost driver” (p. 489). The REV is the “realizable end value”, a measurement referred to a value estimation which “must move from the split-off point to the point of product usage where the users will estimate value in terms of the relative importance of the various joint product outcomes” (p. 483). Trenchard and Dixon (2003) propose a second stage of the previous study, starting from the conceptual basis provided by model developed by Balachandran and Ramakrishnan (1981), which combines the advantageous properties of the Moriarity model and the Louderback model. The authors remanded to the two-phase model advocated by Balachandran and Ramakrishnan (1996). In both abovementioned cases, the ABC-like perspective is applied as a cost driver seeking methodology, but neither the former nor the latter strictly use the ABC methods as joint cost allocation method. Within their first study on this topic the authors, indeed, identify the REV as value-based cost driver; while in the second one they develop a combined common/joint cost model based on the product quality, which is proportional to its application usefulness.

In order to offer support in the efficient use of the Blood Centre’s resources, Lowe (1997) proposes an application of a conventional costing technique to the costing of blood products. The empirical study (which constitutes a part of his work addressed to examining the role of accounting in health reforms) the apportionment of joint costs (related to collection and testing) are calculated by “using a combination of physical volume measures and an arbitrary split of costs over the four ‘main’ products: whole blood, red cells, platelets, and plasma. The split was agreed on following discussion between the manager of the blood center and the divisional accountant to reflect the resources expended in processing the primary products to this stage” (p. 448). Lowe (1997) also specified that the equivalent cost per unit of product does not consider the differences in volume.

In the aim of estimating plasma production costs, to allow for comparisons between Italian regions, Eandi et al.
In the empirical studies conducted by Fragoulakis et al. (2014) and Mafirakureva et al. (2016) the ABC method is applied in order to calculate blood component costs. Both studies referred to the method recommended by The Italian NHS, public blood centers carry out all phases of blood product collection from the blood collection to the storage of blood components; instead, plasma fractionation is carried out by authorized manufacturers (Eandi et al., 2015).

In the empirical studies conducted by Fragoulakis et al. (2014) and Mafirakureva et al. (2016) the ABC method is applied in order to calculate blood component costs. Both studies referred to the method recommended by The Cost of Blood: Multidisciplinary Consensus Conference for a Standard Methodology (Participants of the Charleston, 2005). Fragoulakis et al. (2014) developed an in-depth analysis of all cost elements associated with the process flow of blood production, highlighting direct costs and indirect costs (mainly overhead) for each activity. They presented all the parameters needed to allocate indirect costs to blood activities (following the recommendations in Participants of the Charleston, 2005) and assert that “the main parameters that determined the variation in cost among hospitals were the number of staff employed in blood centers, the number of blood units produced, and the percentage of wastage of blood units” (p. 1035). At the end of their work, the authors reported the cost of one unit of whole blood. Thus, it was not possible to track the joint cost-allocation method to each component. In Mafirakureva et al. (2016), instead, the production costs of each component are reported. The authors declared that “The number of components produced for each component category was used to apportion the joint processing costs” (p. 633). It is worth of notice, however, that considering the number of components produced as the cost driver does not appear consistent with the cause and effect criterion in allocating the joint costs to the cost objects (Bhimani et al., 2015; Horngren, 2011). Although the ABC method, based on causality principle (Cooper, Kaplan, Maisel, Morrissey, & Oehm, 1992; Cooper & Kaplan, 1992), may be applied in calculating the amount of joint costs generated before the split-off point, as well as the separable costs beyond the split-off point, it is not feasible to apply the ABC methods in allocating joint costs to the split products.

6. Conclusion

The present paper searches to offer an in-depth review of cost-allocation methods used in different countries for price-setting or for determining the cost-effectiveness of blood products. Almost all of the studies examined consider joint costing issues that arise in determining the cost of production of blood components, derived from whole blood or apheresis procedures. At the same time, even if with different emphasis, accounting and economic scholars have recognized a certain degree of arbitrariness which could occur in defining the costs of split products (Biddle & Steinberg, 1984) wherever there is a joint production process. At the same time, the literature review shows that the cost of blood products or blood price-setting is clearly an issue in the numerous legislative proposals at the national and state levels and represents a matter of public interest and of public regulation. Despite this, the present work highlights that there are only a limited number of studies that examine blood product costs, with a focus on the joint-costing issues. In applying economic models rather than accounting methodology, some scholars have brought to light the problems arising from the continuous search for a neutral method for allocating joint costs in the blood production sector. As pointed out in the introduction of the present work, numerous studies have focused on the bottom line values of blood costs for the health system (see, for example, Surgenor et al., 1973; Toner et al., 2011; Varney & Guest, 2003). Nevertheless, the cost accounting and reimbursement system effectively underlying the acquisition, screening, and transfusion of blood appears, in practice, to be largely obscure. Finally, very little is known about the level of “relative importance” assigned to each product in the costing setting.

This study has taken a broad look at joint costing in blood production sector and the issues emerging in this field. It offers an overview of the current status in the economic and accounting literature, contributing in synthesizing and systematizing the discussion on the cost/price of blood products.

The present study suffers some limitations, typical of literature reviews. By only using the databases provided by
major publishers (Elsevier, Emerald, Springer, Wiley) and Google Scholar, this work may not have achieved complete coverage of all empirical articles in the field. Moreover, only phrases and key words quoted in the research method are used in the searching step: not synonyms and related terms are considered. In addition, a complete review of the literature could be hampered by the fact that in the researching and selection of studies, documents not written in English are excluded. Finally, the paper is limited to researches on blood costing and blood pricing. There are potentially studies that investigate similar phenomena, but discuss it with different terms, and thus, were difficult to find.

The results of the literature review developed in various research areas (in accounting, economics, and medical science) offer relevant insights into a multitude of research streams. Investigations in this area are recommended to:

- Develop a conceptual model by using quantitative and qualitative mixed method in order to obtain less arbitrary results;
- Investigate the relationships between a national system of healthcare services and the cost-allocation methods used to determine the cost/price of blood components;
- Examine the effect of public regulation on blood costs;
- Evaluate the opportuneness of a neutral method that considers the benefit-value to patients.

Moreover, the proposed researches could offer relevant insights in identifying a cost-allocation method that may be used to determine the cost of plasma-derived medicinal products borne by pharmaceutical companies and the price-setting (cost-based) applied to users. In this further research field, the multiple split-off points beyond the plasma-derived production must be considered (Burnouf, 2007): the first split-off point in the raw material production (plasma) discussed in the present study and other split-off points in the manufacturing process of plasma-derived products.

References


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