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Pharmacologic Hemostatic Agents in Total Joint Arthroplasty—A Cost-Effectiveness Analysis

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ABSTRACT

Background: Total knee and hip arthroplasties can be associated with substantial blood loss, affecting morbidity and even mortality. Two pharmacological antifibrinolytics, ε-aminocaproic acid (EACA) and tranexamic acid (TXA) have been used to minimize perioperative blood loss, but both have associated morbidity. Given the added cost of these medications and the risks associated with then, a cost-effectiveness analysis was undertaken to ascertain the best strategy.
Methods: A cost-effectiveness model was constructed using the payoffs of cost (in United States dollars) and effectiveness (quality-adjusted life expectancy, in days). The medical literature was used to ascertain various complications, their probabilities, utility values, and direct medical costs associated with various health states. A time horizon of 10 years and a willingness to pay threshold of $100,000 was used.
Results: The total cost and effectiveness (quality-adjusted life expectancy, in days) was $459.77, $951.22, and $1174.87 and 3411.19, 3248.02, and 3342.69 for TXA, no pharmacologic hemostatic agent, and EACA, respectively. Because TXA is less expensive and more effective than the competing alternatives, it was the favored strategy. One-way sensitivity analyses for probability of transfusion and myocardial infarction for all 3 strategies revealed that TXA remains the dominant strategy across all clinically plausible values.
Conclusion: TXA, when compared with no pharmacologic hemostatic agent and with EACA, is the most cost-effective strategy to minimize intraoperative blood loss in hip and knee total joint arthroplasties. These findings are robust to sensitivity analyses using clinically plausible probabilities.

With the aging population, the rates of total knee and hip arthroplasties continue to rise [1,2]. These procedures can be associated with substantial blood loss, which can increase both morbidity and mortality [3–12]. Although multiple blood-loss minimizing strategies, including the use of spinal anesthesia, tourniquets, red blood cell salvage suction tips, and reinfusion drains have been used, they have had varying success [13–16]. Pharmacologic antifibrinolytic agents such as tranexamic acid (TXA; brand name Cyklokapron) and ε-aminocaproic acid (EACA; brand name Amicar) have been shown to help minimize blood loss during total joint arthroplasty (TJA) [17–21], but they also have potential adverse effects including myocardial infarction (MI) and other thromboembolic complications [19,22–28]. Not only are these adverse reactions associated with substantial morbidity and the potential for mortality, but also they place a fiscal burden on the healthcare system [17–21]. In an era of fiscal austerity and migration of reimbursement structures to bundled payment systems, demonstrating the cost-effectiveness of these adjuvant interventions is important. Thus, an analysis was conducted to ascertain the most cost-effective blood loss minimizing strategy in TJA.

Materials and Methods

Patient Population

We modeled a cohort of healthy 65-year-old patients with severe osteoarthritis of the hip or knee. These characteristics represent the typical patient undergoing elective TJA [29]. Patients

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were presumed to have no additional risk factors, with an American Society of Anesthesiologists Physical Status Classification of I [30].

Model Design

An expected value cost-effectiveness model was developed to determine whether single dose intravenous (IV) TXA, single dose IV EACA, or no pharmacologic hemostatic agent would be the most cost-effective approach to minimizing operative blood loss and related complications (Fig. 1). This model was developed using the published literature to ascertain potential complications and their probabilities. Payoffs included (1) cost, representing the direct medical costs for a given strategy in inflation-adjusted 2016 United States Dollars (USD) and (2) effectiveness, measured in quality-adjusted life expectancy (QALE), in days. A total time horizon of 10 years was used to account for complications that occur in a delayed fashion. Measures of costs and effectiveness were discounted at a rate of 3% per year to be consistent with current practices of cost-effectiveness analysis in medicine [31]. The tabulated costs and QALE were used to evaluate the overall cost-effectiveness of the 3 strategies.

Model Parameters

The following general assumptions were made when constructing the model: (1) the patient population was defined as individuals aged 65 years with severe osteoarthritis who have elected to undergo TJA; (2) concurrent health states with differing utilities occurring over the same period were accounted for through the single lowest health utility for that given period; (3) the probability of postoperative anemia for a given strategy was treated as the probability of symptomatic anemia (ie, anemia requiring transfusion) and as such the probability of postoperative anemia was equivalent to the probability of transfusion for a given strategy; (4) patients who needed a transfusion received it on the first day after surgery (ie, postoperative day [POD] #1) [32]; (5) patients who sustained a transfusion reaction only sustained a minor, febrile nonhemolytic transfusion reaction which occurred immediately after transfusion and this health state lasted for 1 POD [33,34]; (6) when a postoperative MI occurred, it always occurred on POD #2 and this health state lasted for the rest of the patient's life unless superseded by a health state with a worse utility [35,36]; (7) patients with symptomatic anemia who did not undergo blood transfusion were assigned to the transfusion-dependent health state for a total of 30 days [37–39]; and (8) prosthetic joint infection (PJI), if occurring, happened at 180 days and this health state remained for the rest of the patient's life [40,41]. Each of the assumptions pertaining to timing of onset and duration of complications and health states was based on the available literature. The parameter values used in this cost-effectiveness model are included in Tables 1-3 and further described below.

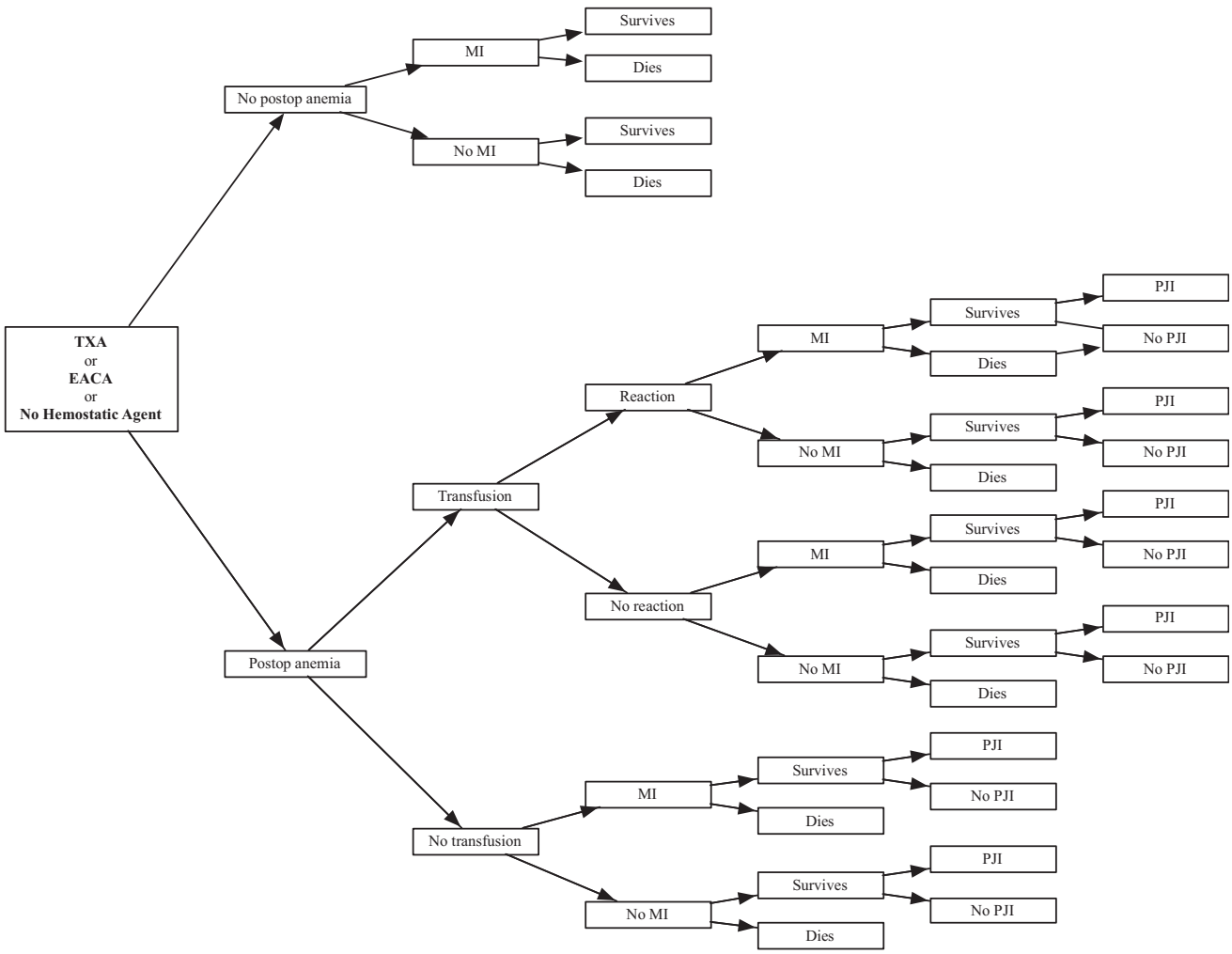

Fig. 1. The expected value cost-effectiveness model in deciding between pharmacologic hemostatic agents in total joint arthroplasty. EACA, ε-aminocaproic acid; MI, myocardial infarction; PJI, prosthetic joint infection; TXA, tranexamic acid.