Perceived barriers among physicians for stopping non–cost-effective blood-saving measures in total hip and total knee arthroplasties

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BACKGROUND: Despite evidence that the blood-saving measures (BSMs) erythropoietin (EPO) and intra- and postoperative blood salvage are not (cost-)effective in primary elective total hip and knee arthroplasties, they are used frequently in Dutch hospitals. This study aims to assess the impact of barriers associated with the intention of physicians to stop BSMs.

STUDY DESIGN AND METHODS: A survey among 400 orthopedic surgeons and 400 anesthesiologists within the Netherlands was performed. Multivariate logistic regression was used to identify barriers associated with intention to stop BSMs.

RESULTS: A total of 153 (40%) orthopedic surgeons and 100 (27%) anesthesiologists responded. Of all responders 67% used EPO, perioperative blood salvage, or a combination. After reading the evidence on non–cost-effective BSMs, 50% of respondents intended to stop EPO and 53% to stop perioperative blood salvage. In general, barriers perceived most frequently were lack of attention for blood management (90% of respondents), department priority to prevent transfusions (88%), and patient characteristics such as comorbidity (81%). Barriers significantly associated with intention to stop EPO were lack of interest to save money and the impact of other involved parties. Barriers significantly associated with intention to stop perioperative blood salvage were concerns about patient safety, lack of alternatives, losing experience with the technique, and lack of interest to save money.

CONCLUSION: Physicians experience barriers to stop using BSMs, related to their own technical skills, patient safety, current blood management policy, and lack of interest to save money. These barriers should be targeted in strategies to make BSM use cost-effective.

During total hip arthroplasty (THA) and total knee arthroplasty (TKA) the calculated visible and invisible blood loss is 1500 mL on average.[1] The ensuing drop of hemoglobin (Hb) of approximately 3 g/dL leads to high rates of allogeneic blood transfusions up to 69% in this patient group, depending on the transfusion threshold.[2,3] Concerns about the risk of (non)infectious transfusion reactions due to allogeneic transfusions have led to the development of blood-saving measures (BSMs) including preoperative erythropoietin (EPO) and intra- and postoperative autologous blood salvage and reinfusion (in short, perioperative

ABBREVIATIONS: BSM(s) = blood-saving measure(s); TDF = theoretical domains interview framework; THA = total hip arthroplasty; TKA = total knee arthroplasty.

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blood salvage) to prevent these allogeneic blood transfusions. Many studies have been performed on the effectiveness of these BSMs, with varying results but mostly in favor of cell salvage. However, reviews showed that these studies had several limitations such as a retrospective design, small patient numbers, and poor methodologic quality. Trials were performed unblinded and lacked adequate concealment of treatment allocation, which may have influenced and biased the results in favor of perioperative blood salvage and EPO.[3-6]

A recent randomized controlled trial conducted by So-Osman and colleagues among approximately 2500 patients was performed to assess the effect of both EPO and perioperative blood salvage in patients receiving a THA or TKA. The results showed that, with a restrictive transfusion trigger, neither EPO nor perioperative blood salvage nor postoperative blood salvage alone were cost-effective in primary elective THA and TKA compared with no BSM use.[7,8] EPO is effective to prevent allogeneic blood transfusions, but at unacceptable high costs (€7300 or approx. $9500 per avoided transfusion) in patients with Hb range between 10 and 13 g/dL. Use of perioperative blood salvage did not avoid transfusion or had a blood-saving effect and consequently increased the costs per patient (€378 or approx. $500 per patient). Therefore, both techniques are considered non–cost-effective in primary elective THA and TKA.[7,8] For revision surgery no conclusions about the (cost-)effectiveness of EPO or perioperative blood salvage could be drawn.[7,8] Another study that advocates the financial benefits for selective use of intraoperative blood salvage was performed under the assumption that every unit of autologous blood replaces a unit of allogeneic blood transfusion. This assumption ignores the possibility that patients undergoing surgery without blood salvage might not need a transfusion and thereby overestimates the effectiveness and hence the cost-effectiveness.[9]

The study results of So-Osman and coworkers[7,8] are in line with recent literature. A number of recent trials that were not included in the currently available meta-analyses show that perioperative blood salvage is not superior to a regular drain or no drain.[10-14] With respect to EPO, other studies also show that EPO is effective but that the costs are too high.[15,16] Despite the availability of this evidence, physicians keep using these BSMs in daily practice. A survey among orthopedic departments in Dutch hospitals showed that approximately 85% of Dutch hospitals use at least one of these BSM types frequently in THA and TKA patients.[17]

To decrease costs of care delivery to patients undergoing primary elective THA or TKA, it is recommended that physicians stop routine use of non–(cost-)effective BSMs. However, little is known about effective interventions to stop current behavior of physicians, that is, deimplementation of non–cost-effective BSMs. Overall, knowledge about barriers that hinder deimplementation of common practices is scarce,[18] whereas much more is known about barriers that hinder the implementation of new guidelines or techniques,[16,19-25] that is, that it requires knowledge, skills, and time to adopt a new technique.

Improved insight into the barriers that are associated with the intention to stop using non–cost-effective BSMs is required to develop effective interventions and thereby to improve the efficiency of care delivery in THA and TKA. Therefore, this study aims to explore and quantify the impact of barriers that hinder physicians to stop the use of non–cost-effective BSMs in primary elective THA and TKA.

MATERIALS AND METHODS

Study design and setting

The study had a cross-sectional design, using an Internet-based questionnaire. The development of this questionnaire was based on in-depth interviews with physicians involved in THA and TKA. Relevant for the setting of this study is that it was performed in the Netherlands where there is no shortage of allogeneic blood and elective surgery is basically never delayed or canceled for this reason. However, costs of blood products are slightly higher when compared with other (European) countries.[26,27] The expenses of EPO are incurred by the outpatient pharmacy and reimbursed by the health care insurance company. The expenses of perioperative blood salvage are paid by the hospital. Physicians are either employed by the hospital or form a partnership of independent entrepreneurs and mostly do not bear the costs for BSMs. The Medical Ethical Committee of the Leiden University Medical Center declared that ethical approval was not required under the Dutch national law (CME 11/104).

Questionnaire development

To explore barriers, semistructured interviews were performed among 10 orthopedic surgeons and 10 anesthesiologists. Orthopedic surgeons and anesthesiologists were considered to be key stakeholders in the decision whether or not to use BSMs in THA and TKA. These physicians stated that it varies per hospital whether the orthopedic surgeons or the anesthesiologists make the decision to use EPO and perioperative blood salvage. Based on a previous survey[17] we selected physicians for the interviews from hospitals with both frequent and nonfrequent use of BSMs, under the assumption that this would provide us with a broad spectrum of perceived barriers.

The interview topic guide was compared with the theoretical construct domains of the theoretical domains interview framework (TDF),[20,23] to ensure that no potentially relevant barriers would be excluded. The TDF

includes 12 different domains derived from a large number of health psychology theories and their theoretical constructs. Previous studies already showed that the TDF is useful in identifying a broad spectrum of barriers and facilitators to change behavior.[20,22-24] The interviews were transcribed in full, coded and analyzed independently by two investigators (VV and MW). In case of disagreement, consensus was reached through discussion. There were 67 barriers reported that partially overlapped and were processed into 53 questionnaire items. To analyze the interviews a software package (ATLAS.ti Scientific Software Development GmbH, Berlin, Germany) was used.

Study population

A random sample of 400 orthopedic surgeons listed in the registry of the Netherlands Orthopaedic Association (n = 595) and a random sample of 400 anesthesiologists listed in the registry of the Netherlands Society of Anesthesiologists (n = 1200) were invited to fill out the questionnaire. We sampled by means of digital number allocation to the registry.

If the invited physician stated that he or she was not involved in THA and TKA, we invited another physician from the same region to fill out the questionnaire. Characteristics of invited physicians (sex and hospital type) were gathered using the Netherlands Orthopaedic Association and the Netherlands Society of Anesthesiologists registries. Data of responders were saved anonymously.

Questionnaire

The Internet-based questionnaire started with two items concerning the current use of EPO and perioperative blood salvage on a 7-point Likert scale ranging from "none" to "to a very large extent." Next, the results of the blood management randomized controlled trial[7,8] were presented (including the costs and limited benefits of EPO and perioperative blood salvage) followed by two items to assess the intention to stop the use of EPO and perioperative blood salvage after responders had read the study results. This was also measured on a 7-point Likert scale ranging from "none" to "to a very large extent." The intention to stop with EPO and the intention to stop perioperative blood salvage were the outcome measures of this study. These outcome measures were used as a proxy for behavior change because it is impossible to measure behavior change in a cross-sectional study design and intention is known to be related to behavior change.[2,28] The last part of the questionnaire consisted of 53 items covering the identified barriers. Physicians who did not use BSMs were asked to fill in these questions as if they used BSMs. Of these questions, 36 started with "To what degree . . ." and answers could be given on a 7-point Likert scale ranging from "none" to "to a very large extent." Furthermore, 16 questions that could not be formulated in this way started with "How important do you find . . .," and answers could be given on a 7-point Likert scale ranging from "not important" to "very important," and there was one question with yes or no answering categories. All physicians were approached by e-mail in August 2012. Reminders were sent 2, 4, and 6 weeks after the first invitation.

Statistical analysis

To quantify the presence of barriers for deimplementation as perceived by the physicians, we dichotomized the 7-point Likert scale items (0-3 no barrier, 4-6 barrier). We described the characteristics of the physicians and the percentage of physicians that perceived the items as barrier.

To identify barriers associated with the intention to stop with either EPO or perioperative blood salvage, we used a multivariate logistic regression model. The outcome measures "intention to stop EPO" and "intention to stop perioperative blood salvage" were dichotomized into "no intention to stop" (0-2) and "intention to stop" (3-6). As the decision to stop or continue the use of BSMs is binary, logistic regression analysis was used, and we tried to be very sensitive by including all physicians who had some intention to stop BSMs so that we would capture the full range of possible barriers. To prevent overfitting of the logistic regression model by including too many variables and to determine the underlying concept of the 53 barriers (in their original 7-point scale), we first grouped coherent barriers. This was done by using an explorative factor analysis with an orthogonal rotation approach, using principal component analysis and varimax rotation.[29] For the interviews we used the TDF.[20,23] However, after analyzing the interviews the identified barriers could fit within more than one domain. Exploratory factor analysis was therefore used, to analyze which factors clustered together into a single factor. The number of factors was determined based on Cattell's scree test.[30]

Barriers were assigned to a factor if their factor loading was greater than 0.30. Barriers with a factor loading of less than 0.30 were not used in subsequent analyses. In case of cross-loading, the barrier was assigned to the factor with the highest loading.[29] This resulted in a number of coherent barriers grouped in factors. We calculated the Cronbach's alpha for each factor to assess their internal consistency.

Within each factor we tested which barriers were significantly associated with the intention to stop EPO and with the intention to stop perioperative blood salvage. An ENTER selection method was applied in this logistic regression analysis including all barriers within a factor.

Variables with p values of less than 0.05 were considered eligible for the following analysis.

Significant barriers within a factor were tested together in a multivariate logistic model. As individual barriers may be related to other barriers, we wanted to assess the independent contribution of each barrier on the intention to stop. In addition, we adjusted for professionals' characteristics (sex, type of hospital, current BSM use). This resulted in a number of barriers that are significantly and independently associated with the intention of physicians. The Nagelkerke R^2 was used to assess the variance explained by the model.[31] The analysis of questionnaire data was executed using a software package (SPSS, IBM SPSS Statistics, Version 20, IBM Corp., Armonk, NY).

RESULTS

The questionnaire was completed by 100 (27%) anesthesiologists and 153 (40%) orthopedic surgeons with a total response of 253 completed questionnaires (34%; Fig. 1). The reason for nonresponse was not verified. Eighty-nine percent of anesthesiologists and 96% of the orthopedic surgeons were male. None of the responding anesthesiologists worked in a private clinic. Responding anesthesiologists worked in 61 different hospitals, and orthopedic surgeons in 76 different hospitals. In total, physicians in 89 of 99 hospitals in the Netherlands responded. EPO was used by 48% of the anesthesiologists and by 41% of the orthopedic surgeons. Perioperative blood salvage was used by 65% of the anesthesiologists and by 50% of orthopedic surgeons. In total 67% of respondents used EPO, perioperative blood salvage, or both. Further characteristics of the responders are shown in Table 1.

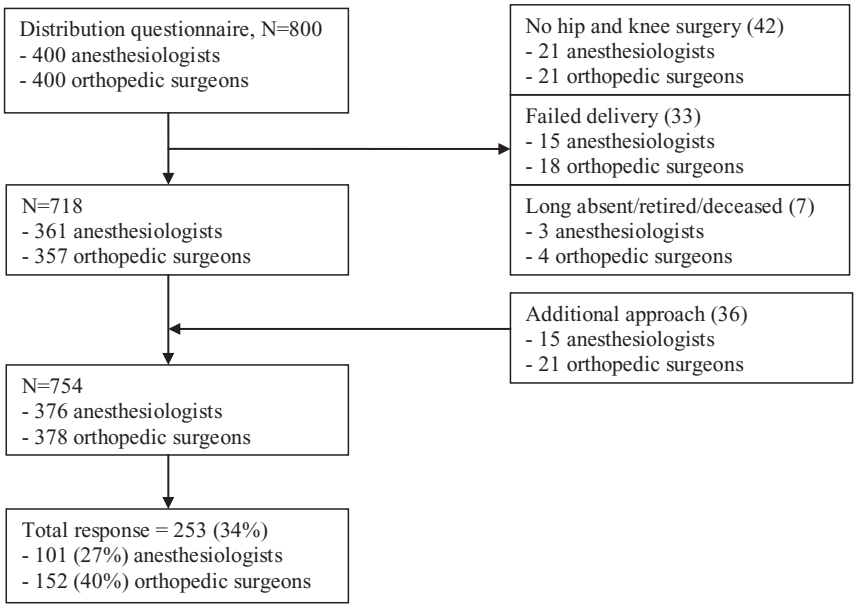

Fig. 1. Flow diagram questionnaire distribution and response.

TABLE 1. Characteristics of the participating physicians (n = 253)

Characteristics	Orthopedic surgeons, n = 153 (response 60%)	Anesthesiologists, n = 100 (response 40%)
Sex		
Male	147 (96)	89 (89)
Type of hospital		
University medical center	16 (11)	19 (19)
Teaching hospital	46 (30)	33 (33)
General hospital	83 (54)	48 (48)
Private clinic	8 (5)	0 (0)
Current use of BSMs		
EPO	63 (41)	48 (48)
Perioperative blood salvage	77 (50)	64 (65)

* Data are reported as number (%).

Quantification of barriers

Data of all respondents were analyzed. Six factors were identified using the Catell's scree-test, representing 42 items that were perceived as barriers. The remaining 11 items did not load sufficiently on the factors (<0.300). Examining the items represented within the six factors, these seem to fit well with six of the TDF domains (Table 2). Each factor consisted of at least six items. The Cronbach's alpha values per factor varied between 0.60 and 0.86. The physicians perceived the items within the factors to varying degrees as barriers (Table 2). Barriers that were perceived most frequently were all in the domain labeled "environmental context and resources": "lack of attention for blood management" (90%), "department priority to prevent blood transfusions" (88%), "patient characteristics such as comorbidity" (81%), and "importance to take experiences of colleagues within the hospital into account" (79%). Table 2 also shows that some potential barriers identified during the interviews were not considered important by the majority of respondents. These were "lack of interest in new developments" (2%)" "lack of importance of recommendations of the physician associations" (1%), and "lack of importance of national guidelines" (1%). These barriers were all in the domain labeled "memory, attention, and decision processes." Although orthopedic surgeons and anesthesiologists perceive the same barriers, there are differences in frequency. Anesthesiologists perceived the

TABLE 2. Number (%) of respondents that perceived an item as barrier (dichotomized)

Questionnaire items	Percentage of physicians who perceive this as a barrier		
	Total (n = 253)	Orthopedic surgeons (n = 153)	Anesthesiologists (n = 100)
Memory, attention, and decision processes ($\alpha = 0.86$)*			
1. Lack of attention for an unequivocal blood management policy	19 (8)	12 (8)	7 (7)
2. Lack of attention for costs of BSMs and transfusions	7 (3)	6 (4)	1 (1)
3. Lack of attention for the number of blood transfusions	7 (3)	5 (3)	2 (2)
4. Lack of attention for literature about BSMs and transfusions	31 (12)	23 (15)	8 (8)
5. Lack of attention for study results compared with own clinical experience about effectiveness of BSMs	15 (6)	10 (7)	5 (5)
6. Lack of attention for new developments	4 (2)	3 (2)	1 (1)
7. Lack of importance of national guideline	4 (2)	3 (2)	1 (1)
8. Lack of importance of recommendations of the professional associations	2 (1)	1 (1)	1 (1)
9. Lack of importance of feedback about BSM use and transfusion rates	10 (4)	8 (5)	2 (2)
Social influences ($\alpha = 0.77$)*			
1. Lack of department priority for cost-effective blood management	48 (19)	23 (15)	25 (25)
2. Difficulty of implementing changes within own department	83 (33)	39 (26)	44 (44)
3. Difficulty of breaking established routines	95 (38)	51 (34)	44 (44)
4. Lack of discussion about blood management within department	31 (12)	12 (8)	19 (19)
5. Lack of agreement within department about the blood management policy	10 (4)	3 (2)	7 (7)
6. Hindered by hospital management to adjust the blood management policy	21 (8)	10 (7)	11 (11)
7. Lack of influence of respondent on blood management policy	13 (5)	5 (3)	8 (8)
8. Lack of influence of department on stopping BSMs	14 (6)	6 (4)	8 (8)
9. Hindered by blood management policy of other medical specialties or blood transfusion committee	42 (17)	25 (17)	17 (17)
Motivation and goals ($\alpha = 0.72$)*			
1. Lack of reliability of TOMaat study results	24 (10)	14 (9)	10 (11)
2. Lack of importance of RCTs in comparison to own clinical experience	14 (6)	7 (5)	7 (7)
3. Lack of benefit for delivery of care	52 (21)	32 (21)	20 (20)
4. Lack of benefit for organization of care delivery	36 (14)	23 (15)	13 (13)
5. Lack of interest to save money for the hospital by stopping blood salvage	94 (38)	51 (34)	43 (43)
6. Lack of interest to save money for the society by stopping EPO	79 (31)	43 (28)	36 (36)
Beliefs about consequences ($\alpha = 0.60$)*			
1. Concerns about losing experience with the use of BSMs	75 (30)	37 (24)	38 (38)
2. Difficulty of letting treatment team stop with EPO	44 (18)	24 (16)	20 (20)
3. Difficulty of letting treatment team stop with perioperative blood salvage	46 (18)	21 (14)	25 (25)
4. Pressure of suppliers to use BSMs	20 (8)	10 (7)	10 (10)
5. Concerns about safety of patients when BSMs are stopped	97 (39)	56 (38)	41 (41)
6. Importance to take patients' opinion into account	131 (52)	68 (45)	63 (62)
Knowledge ($\alpha = 0.65$)*			
1. Convinced of effectiveness of EPO	144 (58)	84 (55)	60 (61)
2. Convinced of effectiveness of perioperative blood salvage	141 (56)	75 (49)	66 (67)
3. Lack of alternatives for EPO	116 (46)	69 (45)	47 (48)
4. Lack of alternatives for perioperative blood salvage	145 (59)	82 (55)	63 (64)
5. Lack of interest to gain additional information about stopping EPO	114 (46)	62 (41)	52 (54)
6. Lack of interest to gain additional information about stopping perioperative blood salvage	120 (48)	67 (44)	53 (54)
Environmental context and resources ($\alpha = 0.65$)*			
1. Department priority to prevent blood transfusions	221 (88)	136 (89)	85 (86)
2. Importance to take experiences with BSMs of colleagues within the hospital into account	198 (79)	124 (82)	74 (74)
3. Importance to take experience with BSMs of colleagues in other hospitals into account	139 (55)	93 (61)	46 (47)
4. Patient characteristics such as comorbidity	202 (81)	120 (79)	82 (83)
5. Lack of attention for blood management	227 (90)	139 (91)	88 (88)
6. Importance to prevent transfusions regardless of costs	127 (51)	77 (51)	50 (50)

* α = Cronbach's alpha coefficient to assess the internal consistency of items within a factor.
RCT = randomized controlled trial; TOMaat = Tranfusie Op Maat (tailored transfusion, study results of So-Osman et al.[7,8]).

following barriers more frequently than orthopedic surgeons: "difficulty of implementing changes within own department" (44% vs. 26%), "importance to take patients' opinion into account" (63% vs. 45%), and "convinced of effectiveness of perioperative blood salvage" (67% vs. 49%; Table 2).

Barriers associated with the physicians' intention to stop EPO

Among respondents, 50% had the intention to stop EPO, with comparable percentages between orthopedic surgeons (50%) and anesthesiologists (51%). When tested within each factor, five eligible barriers significantly associated with the intention to stop EPO use were identified (Table 3A). In multivariate analyses including all significantly associated barriers from all factors, three independent barriers remained significant in the domains labeled: "social influences," "motivation and goals," and "beliefs about consequences." The presence of the barriers "the impact of blood management policy of other medical specialties/blood transfusion committee" ($p = 0.022$) and "pressure of suppliers to use BSMs" ($p < 0.001$) made it more likely that physicians had the intention to stop with EPO. Perceiving the barrier "lack of interest to save money for the society by stopping EPO" on the other hand, made it less likely that physicians had the intention to stop with EPO ($p < 0.001$; Table 3B). Together these three barriers explained 38% of the variance in intention to stop with EPO.

Barriers associated with the physicians' intention to stop blood salvage

Among respondents, 53% had the intention to stop with blood salvage, with slightly more orthopedic surgeons willing to stop when compared with anesthesiologists (57% vs. 46%). When tested within each factor, eight eligible barriers significantly associated with the intention to stop with perioperative blood salvage were identified (Table 4A). In multivariate analyses including all significantly associated barriers from all factors, seven independent barriers remained significant in the domains labeled "social influences," "motivation and goals," "beliefs about consequences," and "knowledge" (Table 4B). The barriers "lack of interest to gain additional information about stopping perioperative blood salvage" ($p = 0.002$) and "lack of influence of respondent on blood management policy" ($p = 0.034$) were, when perceived by physicians, associated with higher intention of physicians to stop perioperative blood salvage. The barriers "lack of benefit for delivery of care" ($p = 0.039$), "lack of alternatives for perioperative blood salvage" ($p = 0.001$), "lack of interest to save money for the hospital by stopping perioperative blood salvage" ($p = 0.040$), "concerns about losing experience with the use of BSMs" ($p = 0.027$), and "concerns about safety of patients when BSMs are stopped" ($p = 0.020$) were, on the other hand, associated with significantly less intention to stop perioperative blood salvage (Table 4B). Overall, 44% of the variance in intention to stop with perioperative blood salvage was explained by these seven barriers.

TABLE 3A. Barriers within each factor significantly associated with the intention to stop EPO

Domain	Barrier	OR*	CI
Memory, attention, and decision processes	Lack of attention for costs of BSMs and transfusions	0.532	0.362-0.781
Social influences	Hindered by blood management policy of other medical specialties or blood transfusion committee	1.278	1.063-1.537
Motivation and goals	Lack of interest to save money for the society by stopping EPO	0.649	0.498-0.846
Beliefs about consequences	Pressure of suppliers to use BSMs	1.595	1.251-2.032
	Concerns about safety of patients when BSMs are stopped	0.770	0.638-0.929

* ORs adjusted for current EPO use: with a one-step increase on the 7-point Likert scale the chance to have the intention to stop with EPO is multiplied by the OR.

TABLE 3B. Barriers significantly associated with intention to stop EPO in multivariate analysis

Domain	Barrier	OR*	CI
Social influences	Impeded by blood management policy of other medical specialties or blood transfusion committee	1.263	1.034-1.544
Motivation and goals	Lack of interest to save money for the society by stopping EPO	0.634	0.518-0.776
Beliefs about consequences	Pressure of suppliers to use BSMs	1.583	1.225-2.046

* OR adjusted for current EPO use: with a one-step increase on the 7-point Likert scale the chance to have the intention to stop with EPO is multiplied by the OR.

TABLE 4A. Barriers within factors significantly associated with the intention to stop perioperative blood salvage

Domain	Barrier	OR*	CI
Social influences	Lack of influence of respondent on blood management policy	1.399	1.002-1.954
Motivation and goals	Lack of benefit for delivery of care	0.719	0.542-0.952
	Lack of interest to save money for the hospital by stopping perioperative blood salvage	0.662	0.498-0.881
Beliefs about consequences	Concerns about losing experience with the use of BSMs	0.815	0.680-0.976
	Concerns about safety of patients when BSMs are stopped	0.745	0.618-0.896
Knowledge	Convinced of effectiveness of perioperative blood salvage	0.682	0.542-0.858
	Lack of alternatives for perioperative blood salvage	0.752	0.595-0.951
	Lack of interest to gain additional information about stopping perioperative blood salvage	1.304	1.032-1.648

* OR adjusted for current perioperative blood salvage use: with a one-step increase on the 7-point Likert scale the chance to have the intention to stop with perioperative blood salvage is multiplied by the OR.

TABLE 4B. Barriers significantly associated with intention to stop perioperative blood salvage in multivariate analysis

Domain	Barrier	OR*	CI
Social influences	Lack of influence of respondent on blood management policy	1.396	1.027-1.899
Motivation and goals	Lack of benefit for delivery of care	0.796	0.642-0.988
	Lack of interest to save money for the hospital by stopping perioperative blood salvage	0.781	0.617-0.989
Beliefs about consequences	Concerns about losing experience with the use of BSMs	0.794	0.647-0.974
	Concerns about safety of patients when BSMs are stopped	0.765	0.611-0.958
Knowledge	Lack of alternatives for perioperative blood salvage	0.648	0.499-0.842
	Lack of interest to gain additional information about stopping perioperative blood salvage	1.336	1.115-1.601

* OR adjusted for current perioperative blood salvage use: with a one-step increase on the 7-point Likert scale the chance to have the intention to stop with perioperative blood salvage is multiplied by the OR.

DISCUSSION

The results of this study show that physicians perceive barriers for deimplementation of EPO and perioperative blood salvage in primary elective THA and TKA on the domains labeled "memory, attention and decision processes," "social influences," "motivation and goals," "beliefs about consequences," "knowledge," and "environmental context and resources." In general, barriers perceived most frequently were lack of attention for blood management (90% of respondents), department priority to prevent transfusions (88%), and patient characteristics such as comorbidity (81%). Although some barriers were perceived by many physicians, these barriers do not necessarily influence the behavior of physicians. Therefore, we assessed which barriers were associated with the intention of physicians to stop with EPO and perioperative blood salvage. These barriers were related to their own technical skills, patient safety, current blood management policy, and the lack of interest to save money, explaining 38 and 44% of the variance in the intention to stop BSMs. This implies that a large proportion of a physician's intention is explained by the identified barriers.

It is notable that four of the identified barriers were associated with higher intention to stop with BSMs. This involves two barriers for EPO: "the impact of blood management policy of other medical specialties/blood transfusion committee" and "pressure of suppliers to use BSMs" and one barrier for perioperative blood salvage: "lack of influence of respondent on blood management policy." It is not likely that this is a causal effect relationship, so that these barriers result in higher intention to stop. Instead, we expect this effect to be the other way around, that it is due to the fact that physicians only perceive these barriers when they have the intention to stop with EPO or perioperative blood salvage and feel hindered by these factors. The last barrier associated with higher intention to stop: "lack of interest to gain additional information" is not necessarily a barrier, as this item might indicate that physicians with enough knowledge about the subject "blood management" have a high intention to stop.

The identified barriers for deimplementation in this study are partly in line with literature concerning implementation of guidelines or "evidence-based practice." In our study physicians experienced barriers through the impact of other medical specialties, transfusion committees, and BSM suppliers on their blood management policy. These environmental factors are also common when it involves implementation.[19,32,33] The same is true for lack of interest in (cost-)effectiveness.[34] However, there are differences. Implementing new techniques or behaviors is hindered by some specific barriers, for example,

lack of knowledge (available evidence), skills, time, or resources that are necessary to perform the new behavior or use a new technique,[20,22,34] whereas stopping current behavior may lack an evident benefit and raises concerns in physicians about the safety of patients and losing experience with a technique as found in this study. Therefore, this study provides a better understanding of barriers associated with deimplementation.

In changing blood management, there are some relevant issues that must be considered. For example, the awareness of transfusion triggers as well as infection risks of allogeneic transfusions may both be important issues with regard to BSM use. However, participating physicians in the interviews stated using a restrictive transfusion protocol as mentioned in the national guideline, with triggers as low as 6.4 g/dL.[35] These statements were in line with a previous survey among chairs of orthopedic departments in the Netherlands, where 96% of orthopedic departments reported using the national transfusion guideline or an extended version of this guideline.[17] The risks for infections due to allogeneic transfusions like hepatitis B and C or human immunodeficiency virus were not mentioned as relevant risks of transfusion in the interviews, when explicitly asked about these risks. This suggests that in the Netherlands, the physicians are aware of the safety of blood transfusions, having a low risk of transfusion related infections. So although these issues are both very relevant, they were not included in the questionnaire as potential barriers that may hinder the implementation of cost-effective blood management given current routine practice in the Netherlands.

Patients undergoing THA or TKA with preoperative anemia form a distinct group in the consideration to stop using BSMs. This group is eligible for preoperative EPO treatment, which is known to be effective in preventing allogeneic transfusions. However, it has also been shown that the costs of this EPO treatment are too high when compared with an allogeneic transfusion.[7,8] Alternative techniques, for example, tranexamic acid or intravenous or oral iron, can be considered instead of EPO and may be more cost-effective.[3,15,16,36] Another distinct group to be aware of in changing blood management policy is the group of patients who refuse allogeneic transfusion (e.g., Jehovah witnesses) or patients who, for instance, due to the presence of alloantibodies, are not able to receive "regular" allogeneic transfusions. These patients might benefit from EPO or perioperative blood salvage, despite the limited (cost-)effectiveness of these techniques.[37] However, it is beyond the scope of this article to produce a guideline or summary on which alternative techniques can be used and which cases might benefit from EPO or perioperative blood salvage.

The barriers that hinder the deimplementation of EPO and perioperative blood salvage are mostly similar, as deimplementation in both cases is hindered by social influences (other specialties, transfusion committee, suppliers) and for both techniques physicians do not have incentives to control costs. However, there are specific barriers that hinder physicians to stop with perioperative blood salvage. Concerns about patient safety and concerns to lose their own experience with the technique suggest that physicians strongly believe in the effectiveness of perioperative blood salvage. This is striking, as there is convincing evidence that shows no overall reduction of transfused patients using this technique.[7,8,10-14] As this study is part of a deimplementation project, these results indicate that a different approach needs to be taken for deimplementation of perioperative blood salvage versus EPO.

A previous survey on the frequency of BSM use showed that more than 85% of Dutch hospitals frequently use either EPO, perioperative blood salvage, or a combination of these non–cost-effective BSMs in THA and TKA.[17]

Due to scientific development of new and better techniques many more current techniques that are applied in real life might become redundant or too expensive. Physicians do not stop with these techniques by themselves as there are numerous barriers that hinder them from doing so. Deimplementation is a relatively new concept and physicians are not used to changing their current behavior and stopping the use of techniques without it being replaced by a newer technique. A strong point of our study is that it is one of the first in the field of implementation that gives insight into barriers relevant for deimplementation. This makes it possible to compare these deimplementation barriers with barriers for implementation. More deimplementation studies are needed to broaden this insight and to identify barriers that can be addressed in specific situations.

Another strong point of this study is that the barriers in the questionnaire were based on previously identified factors during interviews with involved physicians. This ensures that the questionnaire does not test the authors' personal hypothesis but represents the complete set of possible barriers. Also the fact that we related the barriers to the intention to stop is a strong point. This ensures that the identified barriers are relevant to change behavior.

A limitation of the study is the national setting. The recent trial showing that EPO and perioperative blood salvage were not cost-effective was performed in the Netherlands. The availability, price, and reimbursement of blood products and BSMs may vary per country and therefore study results cannot simply be extrapolated to other countries. The same is true for the identified barriers, which may also vary due to variance in the organization of health care (e.g., incentives to reduce costs).

A second limitation is the low response rate to the questionnaire of 34%. This can lead to response bias. We

would expect that if an unequal ratio of users versus nonusers of BSMs would respond to our questionnaire, when compared with the total study population, this would create bias. Therefore we asked physicians about their current use and adjusted for that in the analyses.

Another possible limitation may be the outcome measure. We used "intention to stop" as outcome. However, having the intention to stop does not mean that a physician will actually stop. Although we asked about current use, we did not measure the actual frequency of use of EPO and perioperative blood salvage with our questionnaire. Therefore, future work includes testing a deimplementation intervention that is developed based on the barriers identified in this study, with actual BSM use before and after our intervention as primary outcomes.

In conclusion, this study has identified the main barriers associated with the intention to stop the use of EPO as well as perioperative blood salvage in primary elective THA and TKA among orthopedic surgeons and anesthesiologists. To effectively deimplement EPO and perioperative blood salvage in primary elective THA and TKA and to make health care more cost-effective, it is important to target the identified barriers and domains. This should be included in strategies to encourage physicians to stop using BSMs.

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CONFLICT OF INTEREST

The authors have disclosed no conflicts of interest.

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