Home Study Program

Intraoperative use of autologous platelet-rich and platelet-poor plasma for orthopedic surgery patients

The article "Intraoperative use of autologous platelet-rich and platelet-poor plasma for orthopedic surgery patients" is the basis for this *AORN Journal* independent study. The behavioral objectives and examination for this program were prepared by Rebecca Holm, RN, MSN, CNOR, clinical editor, with consultation from Susan Bakewell, RN, MS, BC, education program professional, Center for Perioperative Education.

Participants receive feedback on incorrect answers. Each applicant who successfully completes this study will receive a certificate of completion. The deadline for submitting this study is Oct 31, 2007.

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Behavioral Objectives

After reading and studying the article on use of autologous platelet-rich plasma (PRP) and platelet-poor plasma (PPP) for orthopedic surgery patients, nurses will be able to

1. define autologous PRP and PPP,
2. describe clinical outcomes for the use of autologous PRP,
3. discuss how PRP and PPP are obtained,
4. explain how platelet growth factors function in regard to wound healing, and
5. identify contraindications for the use of autologous PRP and PPP.

AORN Home Study

This program meets criteria for CNOR and CRNFA recertification, as well as other continuing education requirements.

A minimum score of 70% on the multiple-choice examination is necessary to earn 1.6 contact hours for this independent study.

Purpose/Goal: To educate perioperative nurses about using autologous platelet-rich and platelet-poor plasma in orthopedic surgical procedures.

Home Study Program

Intraoperative use of autologous platelet-rich and platelet-poor plasma for orthopedic surgery patients

Kathleen M. Floryan, RN; William J. Berghoff, MD

Use of autologous platelet concentrate to accelerate soft and hard tissue healing is strongly supported in medical literature. Studies report accelerated bone regeneration, reduced inflammation, decreased blood loss, reduced postoperative narcotic requirements, and improved hard and soft tissue wound healing.[1] Initially, intended for use in patients undergoing total knee arthroplasty (TKA), its use has expanded to

- bone fractures;
- laminectomy procedures;
- lateral epicondylitis (ie, tennis elbow);
- nonunion and bony defects;
- other total joint arthroplasty procedures (eg, hip, shoulder);
- plantar fasciitis;
- shoulder arthroscopy and distal clavicle resection; and
- spinal fusion.

New products and instruments frequently are introduced in the perioperative environment; however, perioperative nurses often are not well versed in the scientific rationale behind use of these novel devices before they are introduced in the OR setting. This was the experience of nursing staff members at Parkview Orthopaedic Hospital, Fort Wayne, Ind, in 2003 when intraoperative use of autologous platelet-rich plasma (PRP) and platelet-poor plasma (PPP) was introduced. The purpose of this article is to help other perioperative nurse who may be introduced to this technology. This article defines autologous PRP and PPP; describes processing and application of PRP and PPP; and reports clinical application outcomes of the use of platelet concentrate for a group of patients who underwent TKA.

ABSTRACT

- **AS USE OF AUTOLOGOUS platelet-rich plasma (PRP) and platelet-poor plasma (PPP) increases for intraoperative care of a variety of patients, it is important for perioperative nurses to recognize their benefits.**
- **AUTOLOGOUS PRP may decrease postoperative drainage, reduce narcotic requirements, and facilitate an early return to mobility.**
- **POSTOPERATIVELY, PATIENTS should experience fewer complications, recover more rapidly, and have a reduced hospital stay.**
- **THIS ARTICLE defines autologous PRP and PPP, describes processing and application of PRP and PPP, and reports clinical outcomes of the use of platelet concentrate for a group of patients who underwent total knee arthroplasty. *AORN J* 80 (October 2004) 668-674.**

BACKGROUND

Autologous PPP (ie, autologous fibrin glue) was first described in 1972.[2,3] Autologous PRP also may be called platelet concentrate, platelet gel, and autologous platelet gel.[4] Autologous platelet gel was developed in the early 1990s as a by-product of PRP sequestration in cardiac surgery.[5] Autologous platelet gel is produced from PRP and has two to four times the concentration of platelets. Normal platelet counts range between 150,000 platelets per cubic millimeter (mm^3) and 350,000 platelets per mm^3, averaging approximately 200,000 platelets per mm^3. Platelet-rich plasma is measured as 1,000,000 platelets per mm^3.[4]

The developing body of medical literature documents use of autologous platelet gel and PPP in cardiothoracic surgery; cosmetic and plastic surgery; ear, nose, and throat surgery; general surgery; major vascular surgery; neurosurgery; obstetrics and gynecological surgery (ie, cesarean section, hysterectomy); ophthalmology; oral surgery; orthopedic surgery; urology; and wound healing.[6] Further study is ongoing in all these fields regarding the effectiveness of autologous PRP use. It should be noted that autologous platelet gel is not approved by the US Food and Drug Administration for use as a biologic agent. Combining PRP with thrombin and calcium to create a gel is considered to be the practice of medicine.[7]

Figure 1 • An RN, a perfusionist, or a certified laboratory technician fills the disposable tube with blood.

Figure 2 • The blood tube is placed into the platelet separation system centrifuge that spins for 12 minutes at 3,200 revolutions per minute.

How are PRP and PPP Obtained and Why are They Used?

Parkview Orthopaedic Hospital uses a platelet concentrate system to obtain PRP and PPP. Platelets are separated from 30 mL to 55 mL of whole autologous blood collected from a patient preoperatively, preferably 45 minutes to one hour before induction of anesthesia. The platelet concentrate system used at Parkview Orthopaedic Hospital includes a single-use separation kit with a syringe primed with anticoagulant citrate dextrose solution A (ACD-A).[8] Proper safety precautions for preventing needle stick injuries are used.

The sterile, nonpyrogenic ACD-A solution contains citric acid, sodium citrate, and dextrose in water and is used as an anticoagulant in autologous blood collection and reinfusion, as well as in routine or therapeutic apheresis procedures. Experience has demonstrated that a 5-mL dose of ACD-A for every 30 mL to 55 mL whole blood prevents unwanted clotting. The blood is separated via a single, 12-minute centrifuge spin, which collects approximately 6-mL PRP and 30-mL PPP per 55 mL of separated whole blood (Figures 1, 2, 3).

Platelets contain growth factors (ie, cytokines) which support and accelerate bone and soft tissue healing (Table 1).[9,10] These growth factors are activated when autologous platelets are combined with 5,000 units topical thrombin and 5 mL of 10% calcium chloride using a 10:1 ratio of PRP to the thrombin/calcium chloride solution. Activation refers to the initiation of the clotting cascade of fibrinogen to fibrin and the degranulation of platelets.

Figure 3 • The platelet-poor plasma (ie, top layer), platelet-rich plasma (ie, buffy-coat middle layer), and red blood cells (ie, bottom layer) are separated.

The properties of autologous platelet gel and its contained growth factors are well described.[7] Platelet-derived growth factor (PDGF) assists in the stimulation of cell division at the injury site, which promotes angiogenesis, reepithelialization, and the formation of granulation tissue. The PDGF also is responsible for stimulating osteoblast and collagen production. Platelet concentrates also have the potential to improve fracture healing and enhance osteogenesis.[9] Transforming

TABLE 1
Growth Factors in Platelets

Growth factor	Abbreviation
Epidermal growth factor	EGF
Fibroblast growth factor	FGF
Insulin-like growth factor	IGF
Platelet-derived angiogenesis factor	PDAF
Platelet-derived growth factor	PDGF
Transforming growth factor (ie, alpha, beta)	TGF
Vascular endothelial growth factor	VEGF

growth factor-beta (TGF-b) enhances bone ingrowth and mechanical fixation of implants; this suggests that coating a prosthesis with TGF-b may help improve the functional outcome of total joint replacements.[11] The concentration of growth factors in autologous platelet gel is significantly higher than that found in whole blood from the same patient, resulting in 10 to 25 times more PDGF and TGF-b than at the baseline level.[12] The clinical application of autologous platelet gel, therefore, has the potential to improve soft and bone tissue healing and enhance osteogenesis.[9,13,14]

Autologous platelet gel also has potential for use as a hemostatic agent because it binds tissues and locally activates the coagulation cascade. When the coagulation cascade is activated, high concentrations of platelets adhere to the wound surface. Platelet activation and degranulation releases a number of hemostatic substances.[15]

PREPARING THE PRP AND PPP

Preoperatively, an RN, a perfusionist, or a certified laboratory technician (LT) draws 55 mL of the patient's blood for each knee into an ACD-A primed syringe. The patient should be assessed for appropriate venous access, and if necessary, the blood can be drawn by the anesthesia care provider just after induction and before the start of surgery. The individual collecting the blood immediately labels the primed blood syringe with patient specific identifiers (eg, name, birth date, medical record number) before it is taken for processing to the sterile core just outside the OR where the centrifuge is maintained. After completing competency training and evaluation, an RN, a perfusionist, or an LT can easily operate the centrifuge and process the PRP and PPP. A perfusionist is available in the OR at Parkview Orthopaedic Hospital to perform this task. Having one individual perform the phlebotomy, process the blood, and bring the separated PRP and PPP to the OR reduces the potential for error and improves patient safety.

The LT brings the platelet-rich concentrate (ie, 6-mL to 10-mL buffy coat—middle layer) and PPP to the OR after drawing them into separate sterile syringes. The circulating nurse verifies that the PRP and PPP syringes contain the patient's blood using the same quality checks used for administering any blood product. The circulating nurse aseptically prepares 5,000 units topical thrombin and 5 mL 10% calcium chloride solution. He or she then aseptically transfers the PRP and PPP from the syringes into separate sterile medicine cups on the sterile back table. The circulating nurse draws up the thrombin-calcium chloride solution into a sterile syringe and aseptically transfers it into a third sterile cup on the sterile back table. Maintaining sterility of the blood is paramount and integral to preventing postoperative complications, such as infection or delayed wound healing. Minimizing the number of people involved in processing and transferring the blood product is a primary consideration.

The scrub person then prepares the PRP and PPP by using two separate surgical sealant kit applicators on the back table. The scrub person draws up the thrombin-calcium chloride solution

Figure 4 • Applicator filled with platelet-rich plasma and thrombin-calcium chloride solution.

from the sterile cup on the sterile field into a 1-mL tuberculin syringe and the PRP into a 10-mL syringe. He or she connects these two syringes using a syringe holder (ie, flat plate applicator with holes and plunger clip) (Figure 4). The surgeon uses this applicator to spray the PRP/thrombin-calcium solution on the implant and tissues, thus creating the autologous platelet gel (Figure 5). The surgeon applies the autologous platelet gel to cut bone surfaces, synovia, tendons, and the lining of the wound at closure (Figure 6). The scrub person prepares the PPP in a similar fashion. The surgeon applies PPP to the subcuticular surface before closing the incision with staples (Figure 7).

Documentation of autologous platelet gel and PPP use typically is listed on the implant log in the patient's medical record, whereas use of the thrombin-calcium chloride solution is included on the medication record. Further notation regarding application of the autologous platelet gel and PPP is made by the surgeon in the surgical report. It is not recommended to keep autologous platelet gel longer than six hours at room temperature, even though the platelets still may be active for several days.[16]

Clinical Trial

Throughout 2003, William Berghoff, MD, orthopedic surgeon with Orthopaedic Northeast, Inc, Fort Wayne, Ind, conducted a clinical trial by applying autologous platelet gel and PPP in a group of TKA patients (n = 27) and comparing their outcomes to those of patients in a control group (n = 13) (Table 2). The hospital research and

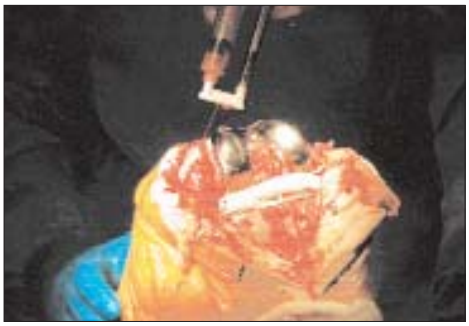


Figure 5 • Autologous platelet gel is applied to the total knee arthroplasty implant.

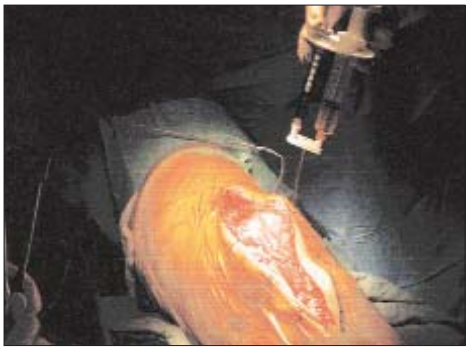


Figure 6 • Autologous platelet gel is applied to cut bone surfaces, synovia, tendons, and the lining of the wound.

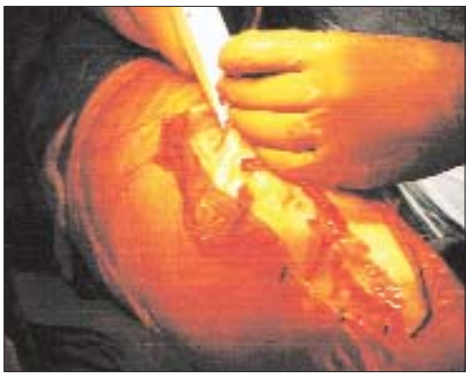
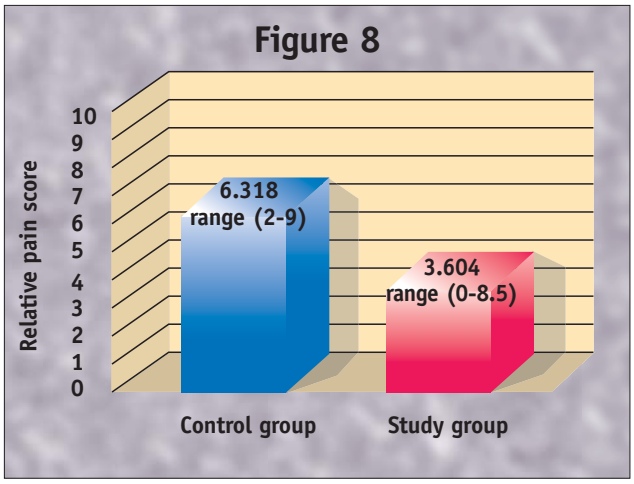
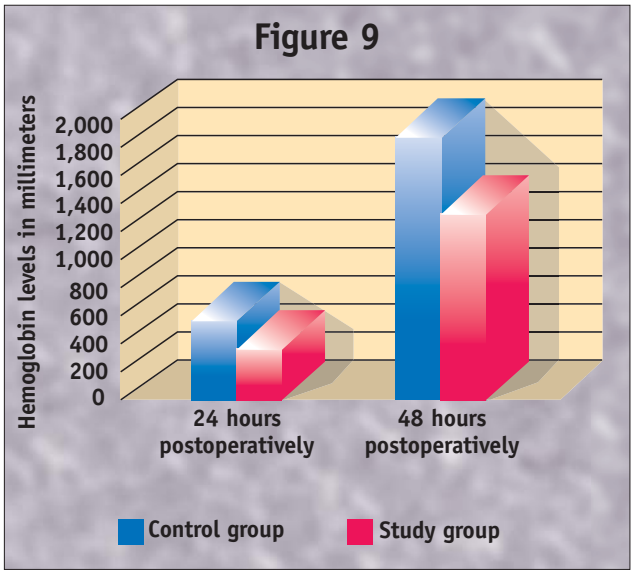


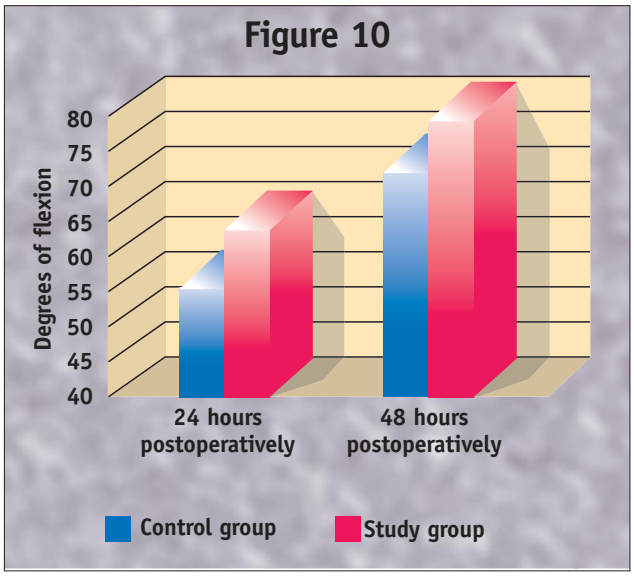
Figure 7 • The surgeon closes the patient's skin with staples after applying platelet-poor plasma to the subcutaneous layer.

Table 2
Clinical Trial Demographics

	Control group	Platelet concentrate group
Gender		
Male	3	11
Female	10	16
Weight		
Mean weight	93 kg	87 kg
Range	64 kg to 127 kg	42 kg to 115 kg
Age		
Mean age	65	66
Range	51 to 84	44 to 83







Postoperative requirements for narcotics were decreased in the study group *(figure 8, top)*, and postoperative wound drainage was decreased according to hemoglobin levels *(figure 9, middle)*. In addition, functional range of motion increased in the first 24 to 48 hours according to degrees of flexion *(figure 10, bottom)*.

review board approved the clinical trial before its onset. After Dr Berghoff fully explained and discussed the benefits and potential adverse effects of PRP and PPP use, each patient signed separate informed consents for phlebotomy and for the application of the autologous platelet gel.

The autologous platelet gel/PPP group results demonstrated

- decreased postoperative requirements for both IV and oral narcotics as measured by the patients' reported numbers on a pain scale of one to 10 (ie, 0 = no pain, 10 = the greatest imaginable pain) (Figure 8) and eight study group patients reported postoperative pain scores of two or lower;
- decreased postoperative drainage as measured by hemoglobin levels (Figure 9); and
- greater functional range of motion in the first 24 to 48 hours as measured by degrees of flexion (Figure 10).

Dr Berghoff's findings have been supported in similar studies.[17]

Discussion

Autologous platelet gel and PPP are obtained easily by simple preoperative phlebotomy. Separation of the blood components into the PRP, PPP, and red blood cells is accomplished with a specialized centrifuge. Using autologous platelet gel and PPP intraoperatively is quick and effective.

As the use of autologous PRP and PPP expands in the intraoperative care of a variety of patients, it is important for perioperative nurses to recognize their benefits. The use of autologous platelet gel in the small group studied resulted in decreased postoperative drainage, reduced intravenous and oral narcotic requirements, and an early return to mobility. These outcomes help improve patients' self-reliance and

increase their satisfaction with care. Additionally, the knowledge that a patient has received autologous platelet gel intraoperatively has implications for postoperative care. Patients should experience fewer complications, recover more rapidly, and have a reduced length of hospital stay. Some reports indicate that recovery times are reduced 25% to 40%.[18] There are reported contraindications for the use of autologous platelet gel and PPP in patients with

- platelet dysfunction syndrome,
- critical thrombocytopenia,
- hypofibrinogenemia,
- hemodynamic instability, and
- sensitivity to bovine thrombin.[7]

Perioperative nurses should expect use of autologous platelet gel and PPP to increase as clinical trials continue throughout the country and more indications are found for their use. ❖

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William J. Berghoff, MD, is an orthopedic surgeon with Orthopaedics Northeast, Inc, Fort Wayne, Ind.

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Examination

Intraoperative use of autologous platelet-rich and platelet-poor plasma for orthopedic surgery patients

AORN Home Study

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1. Autologous platelet concentrate has been shown to
1. accelerate bone regeneration.
2. decrease blood loss.
3. improve hard and soft tissue wound healing.
4. reduce inflammation.
5. reduce postoperative narcotic requirements.

a. 1 and 2
b. 2, 3, and 5
c. 3, 4, and 5
d. 1, 2, 3, 4, and 5

2. Platelet-rich plasma (PRP) may also be called platelet concentrate or platelet gel.
a. true
b. false

3. Platelet-rich plasma contains
a. 200,000 platelets per mm^3.
b. 350,000 platelets per mm^3.
c. 1,000,000 platelets per mm^3.
d. 2,000,000 platelets per mm^3.

4. Autologous PRP is approved by the US Food and Drug Administration for use as a biologic agent.
a. true
b. false

5. The anticoagulant citrate dextrose solution A (ACD-A) used with the platelet concentrate system
a. ensures sterility during the blood collection process.
b. ensures proper platelet separation.
c. prevents the patient's body from rejecting the PRP.
d. prevents unwanted clotting.

6. Approximately how much PRP and plasma-poor platelets (PPP) can be produced from 55 mL whole blood?
a. 5-mL PRP and 20-mL PPP
b. 6-mL PRP and 30-mL PPP
c. 10-mL PRP and 35-mL PPP
d. 15-mL PRP and 40-mL PPP

7. Thrombin and calcium chloride are combined with the autologous platelets to
a. activate growth factors.
b. activate uncalcified bone matrix.
c. prevent hemostasis.
d. prevent the clotting cascade.

8. Platelet-derived growth factor
1. assists in the stimulation of cell division at the injury site.
2. enhances bone ingrowth and mechanical fixation of implants.
3. promotes angiogenesis.
4. promotes formation of granulation tissue.
5. promotes reepithelialization.
6. stimulates osteoblast and collagen production.

a. 1, 2, and 5
b. 2, 3, 4, and 6
c. 1, 3, 4, 5 and 6
d. 1, 2, 3, 4, 5, and 6

9. Although the platelet may be active for several days, it is not recommended that PRP be kept at room temperature longer than
a. one hour.
b. six hours.
c. 12 hours.
d. 24 hours.

10. Contraindications for the use of autologous PRP and PPP include patients with
1. critical thrombocytopenia.
2. hemodynamic instability.
3. hypofibrinogenemia.
4. platelet dysfunction syndrome.
5. sensitivity to bovine thrombin.

a. 1 and 2
b. 2, 3, and 5
c. 3, 4, and 5
d. 1, 2, 3, 4, and 5

Answer Sheet

CH02

Intraoperative use of autologous platelet-rich and platelet-poor plasma for orthopedic surgery patients

AORN Home Study

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Mark only one answer per question.

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2	A B C D E	7	A B C D E
3	A B C D E	8	A B C D E
4	A B C D E	9	A B C D E
5	A B C D E	10	A B C D E

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Learner Evaluation

Intraoperative use of autologous platelet-rich and platelet-poor plasma for orthopedic surgery patients

AORN Home Study

This evaluation is used to determine the extent to which this Home Study Program met your learning needs. Rate these items on a scale of 1 to 5.

Purpose/Goal: To educate perioperative nurses about using autologous platelet-rich and platelet-poor plasma in orthopedic surgical procedures.

Objectives

To what extent were the following objectives of this Home Study Program achieved?

1. Define autologous platelet-rich plasma (PRP) and platelet-poor plasma (PPP).
2. Describe clinical outcomes for the use of autologous PRP.
3. Discuss how PRP and PPP are obtained.
4. Explain how platelet growth factors function in regard to wound healing.
5. Identify contraindications for the use of autologous PRP and PPP.

Content

To what extent

6. did this article increase your knowledge of the subject matter?
7. was the content clear and organized?
8. did this article facilitate learning?
9. were your individual objectives met?
10. did the objectives relate to the overall purpose/goal?

Test Questions/Answers

To what extent

11. were they reflective of the content?
12. were they easy to understand?
13. did they address important points?

Learner Input

14. Will you be able to use the information from this Home Study in your work setting?
    a. yes b. no
15. I learned of this Home Study via
    a. the *Journal* I receive as an AORN member.
    b. a *Journal* I obtained elsewhere.
    c. the AORN web site.
    d. *SSM Online.*

Session Number

13109

	(Low)			(High)		(Low)			(High)
1	①	②	③	④	⑤	11	①	②	③	④	⑤
2	①	②	③	④	⑤	12	①	②	③	④	⑤
3	①	②	③	④	⑤	13	①	②	③	④	⑤
4	①	②	③	④	⑤	14	①	②	③	④	⑤
5	①	②	③	④	⑤	15	①	②	③	④	⑤
6	①	②	③	④	⑤	16	①	②	③	④	⑤
7	①	②	③	④	⑤	17	①	②	③	④	⑤
8	①	②	③	④	⑤	18	①	②	③	④	⑤
9	①	②	③	④	⑤	19	①	②	③	④	⑤
10	①	②	③	④	⑤	20	①	②	③	④	⑤

16. What factor most affects whether you take an *AORN Journal* Home Study?
    a. need for contact hours
    b. price
    c. subject matter relevant to current position
    d. number of contact hours offered

What other topics would you like to see addressed in a future Home Study Program? Would you be interested or do you know someone who would be interested in writing an article on this topic?

Topic(s): _____

_____

Author names and addresses: _____

_____

_____

_____