

# Adaptation of Evidence-based Surgical Wound Care Algorithm

Han, Jung Yeon<sup>1</sup> · Choi-Kwon, Smi<sup>2</sup>

<sup>1</sup>Research Assistant, Department of Biobehavioral Nursing Science, Seoul National University, Seoul

<sup>2</sup>Professor, College of Nursing, Research Institute of Nursing Science, Seoul National University, Seoul, Korea

**Purpose:** This study was designed to adapt a surgical wound care algorithm that is used to provide evidence-based surgical wound care in a critical care unit. **Methods:** This study used, the 'ADAPTE process', an international clinical practice guideline development method. The 'Bonnie Sue wound care algorithm' - was used as a draft for the new algorithm. A content validity index (CVI) targeting 135 critical care nurses was conducted. A 5-point Likert scale was applied to the CVI test using a statistical criterion of .75. **Results:** A surgical wound care algorithm comprised 9 components: wound assessment, infection control, necrotic tissue management, wound classification by exudates and depths, dressing selection, consideration of systemic factors, wound expected outcome, reevaluate non-healing wounds, and special treatment for non-healing wounds. All of the CVI tests were  $\geq .75$ . Compared to existing wound care guidelines, the new wound care algorithm provides precise wound assessment, reliabilities of wound care, expands applicability of wound care to critically ill patients, and provides evidence and strength of recommendations. **Conclusion:** The new surgical wound care algorithm will contribute to the advancement of evidence-based nursing care, and its use is expected as a nursing intervention in critical care.

**Key words:** Critical illness, Surgery, Wounds and injuries, Evidence-based nursing, Practice guideline

## INTRODUCTION

Patients in the surgical intensive care unit are severely ill due to basal disease problems and surgical complications. In earlier studies, the correlation between surgical wounds and condition severity was very high (William, Emily, Katie, & Patricio, 2007). Inappropriate wound care in critical patients evoked bacteremia or sepsis after surgery and increased mortality (Petzina et al., 2010). Therefore, wound management of critical patients is a very important part of critical nursing care and health professionals need to place strict focus on wound care.

Intensive wound care can be achieved using trained critical care nurses who comprehensively understand each patient's physiological condition and wound severity (Myers, 2007). Surgical wound care given by critical care nurses was more comprehensive than that deliv-

ered by experts in plastic surgery, general surgery and wound care specialist, because they consider the patient's disease severity and systemic conditions. Also, the nurses' scope of work has recently expanded. Therefore, clinical practice guidelines were needed for nurses to provide effective wound care (Sheer & Wong, 2008). However, until now, any wound guidelines following evidence-based process for critical nursing care have not yet existed in Korea or other countries.

Evidence-based clinical practice guidelines can provide an effective communication tool for health professionals and help them make decisions. Evidence-based clinical practice guidelines include clinical pathways, algorithms, decision trees, protocols, procedures, and so on. Among them, the algorithm can be used easily by novices and experts because they provides simple diagrams for the decision making process that can be understood more easily than other types of clinical practice guidelines (Courtney, 2005).

\*This article is based on a part of the first author's master's thesis from Seoul National University.

Address reprint requests to: Choi-Kwon, Smi

College of Nursing, Seoul National University, 28 Yengeon-dong, Jongro-gu, Seoul 110-744, Korea  
Tel: +82-2-740-8830 Fax: +82-2-745-8017 E-mail: smi@snu.ac.kr

Received: May 29, 2011 Revised: June 16, 2011 Accepted: December 19, 2011

For evidence-based clinical practice guidelines, it can be completed by two methods, 'Development' and 'Adaptation'. In Korea, there are no specific methods for completing clinical practice guidelines. So, the methods in Korea were revised from foreign guideline toolkits. The 'Development' methods that were commonly quoted included SIGN, NIC, and AHA. The 'Adaptation' method, which was developed by Graham and Harrison in 2005 and named as ADAPTE, requires less substantial resources, takes advantages of the existing guidelines and reduces the duplication of effort. As a result, adaptation has been proposed as an option for guideline development (Graham & Harrison, 2005). In Korea, the ADAPTE method was preferred over 'development methods' since it has been extensively used in clinical settings.

Previous researches in Korea about clinical practice guidelines were done such as blood glucose management (Kim, 2009) but these guidelines did not follow evidence-based approaches as like NICE, SIGN, AHA, and ADAPTE. Wound care guidelines in Korea were very limited to critical patients since the guidelines just handle pressure ulcer or do not consider a patient's systemic factors (nutrition, hemodynamic conditions, oxygen saturation, disease etiology, or environmental factors). Moreover, some of the wound care guidelines were just summaries of foreign wound guidelines that were not suitable for Korean medical conditions as though foreign guidelines were evidence-based and well developed. In contrast, some researches about wound care guidelines that followed evidence-based approaches were done in other countries. However, foreign wound care guidelines were also limited to critical patients because most of the wound care guidelines did not follow evidence-based methods as 'Development' or 'Adaptation' and did not demonstrate sufficient evidences (Bolton et al., 2004).

Consequently, existing wound care guidelines do not consider patient systemic factors, critical wound severity, or various treatment options for critically ill patients. That is why adaptation of an evidence-based surgical wound care algorithm is needed for surgical wound care of critical patients. In this study, evidence-based nursing practice is expected to be used in a critical care unit using an evidence-based wound care guideline based upon the adaptation method. The purpose of this study was to 'adaptation an evidence-based surgical wound care algorithm' to improve the quality and specialty of nursing care in the intensive care unit.

## METHODS

### 1. Design

This study has a methodological research design for completing an evidence-based surgical wound care algorithm for critical patients. This study followed the process created from the ADAPTE collaboration in 2009 (ADAPTE collaboration, 2007).

### 2. Procedures

#### 1) Planning: Preparation

The planning step consisted of identifying the topic, reviewing the literature, and selecting a multidisciplinary team (ADAPTE collaboration, 2007). Ten expert panels were selected, including a nursing professor, a surgical intensive care unit manager, a critical care nursing team manager, 5 surgeons, and 2 wound, ostomy, and continence nurses (WOCN).

#### Step 1: Define the clinical questions (scope and purpose)

The clinical questions were termed PICO: P, Patient or Problem; I, Intervention or Treatment; C, Comparison interventions; O, Outcomes (Melnik & Fineout-Overholt, 2005). The PICO questions were applied to create the research evidence of the surgical wound care algorithm.

#### Step 2: Search for guidelines and other relevant documents

The keywords used in the literature review included 'critical care, surgical wound, clinical practice guidelines, and algorithm.' A total of 32 databases were used including the Cochrane Database of Systematic Reviews. Publication dates were limited to 2000–2010. Ultimately, total of 123 papers about surgical wound care algorithms were selected, including 41 randomized controlled trials (RCTs), 37 non-RCTs, 30 cohorts, and 15 miscellaneous studies. These papers were reviewed and evaluated by the expert panels using Scottish Intercollegiate Guidelines Network (SIGN), Jadad, and Chalmers' scale, among others. There was no language limitations placed on the literature reviews.

#### Step 3: Screen retrieved guidelines

The ADAPTE process suggested 5 criteria for evaluating clinical

practice guidelines, including guideline quality, currency, contents, applicability/acceptability and consistency. Quality of guidelines were evaluated by Appraisal of Guidelines Research and Evaluation (AGREE) instrument (ADAPTE collaboration, 2007), while other 4 criteria were evaluated using the toolkits provided from the ADAPTE collaboration. Consensus was achieved by the expert panels using the 'AGREE instrument', and 'ADAPTE toolkits evaluation sheets (i.e. search and selection of evidence, consistency, acceptability/applicability, and checklist of adapted guideline content)'. The evidence level and recommendation strength were evaluated using GRADE method (GRADE Working Group, 2004). In ADAPTE, it suggested the standard to choose the guidelines that will be used for adaptation. Expert panels could choose the guidelines with an average score of 40% or higher in part 3 rigour area in AGREE instrument. More over 40% mean rigour score was a standard for choosing guidelines that will be used in the adaptation process.

#### Step 4: Selection of guidelines and recommendations to create an adapted guidelines

After screening clinical practice guidelines, final wound care guidelines were determined for adaptation through expert discussion. The selection criteria include 5 options: a) REJECT the whole guidelines; b) ACCEPT the whole guidelines and all of its recommendations; c) ACCEPT the evidence summary of the guideline; d) ACCEPT the specific recommendations, and e) MODIFY specific recommendations.

#### Step 5: Preparation of the adapted guideline draft

Once the panels reached a decision about the adapted guideline, a draft of the surgical wound care algorithm was produced. The draft considered the clinical setting contexts in Korea and obtained permission from the author of the original guideline for production of the new surgical wound care algorithm.

#### Step 6: External review for the guideline target audience

In this study, an external review was conducted as a Content Validity Index (CVI) test aiming at critical care nurses (ADAPTE collaboration, 2007). Stevens (1996) sampling method was used to obtain the required study population. Briefly, the number of variables (9 wound contents) were multiplied by 15 and 135 sampling numbers were obtained. The 135 nurses who had more than three years clinical

career in intensive care were selected by convenience sampling for conducting CVI. Statistical criterion for the CVI test was .75 (Lee, Im, Park, & Lee, 2009). The CVI questionnaire included a 5-point Likert scale (Polit & Beck, 2006). The response options were 5-absolutely appropriate, 4-appropriate, 3-slightly appropriate, 2-inappropriate, and 1-absolutely inappropriate.

#### Step 7: Adoption, dissemination and implementation

After the CVI test was completed, the final surgical wound care algorithm was adopted, disseminated and implemented in 8 critical care units of a tertiary hospital.

### 3. Instruments

#### 1) The instruments used for the adaptation process

##### (1) AGREE Instrument

The wound care guideline quality was evaluated by a 6 areas, 23 items of AGREE instrument. The 6 areas were scope, stakeholder involvement, rigour, clarity, applicability and editorial independence. AGREE reliability was  $\kappa = .40-.75$ , and Kendall  $\tau = .69$  (Appraisal of Guidelines Research and Evaluation [AGREE] collaboration, 2003). The calculated AGREE scores were interpreted as higher score equating higher quality. This tool is available without approval.

##### (2) ADAPTE toolkits

The four ADAPTE toolkits were developed from the ADAPTE collaboration to be used during adaptation. The toolkits used in this study included the following evaluation sheets - search and selection of evidence, consistency between evidence, interpretation and recommendations, and acceptability/applicability. This tool is available without approval.

#### 2) Instruments used in the surgical wound care algorithm

##### (1) Bates-Jensen Wound Assessment Tool (BWAT), 2010 version

The Bates-Jensen wound assessment tool was used in this surgical wound care algorithm for wound assessment (Sussman, 2007). This tool provides estimates about wound recovery using assessment scores: the higher the score, the worse the wound condition. This study acquired permission from Bates-Jensen.

##### (2) Mini-Nutritional Assessment-Short Form (MNA-SF), 2006 version

The MNA-SF was used in this surgical wound care algorithm for the nutrition assessment. Score was analyzed based on the point level:  $\geq 12$  points, normal; from 8 to 11 points, nutrition deficiency; and  $\leq 7$  points, severe nutritional deficiency. The tool sensitivity was 96% and the specificity was 98%. This tool is available without approval.

### 3) Data collection, data analysis

Seoul Asan Medical Center international review board approval for this study was obtained on July, 30, 2010 and from Seoul National University, Nursing College on September, 11, 2010. The data collection was accomplished after approval and permission were obtained from the surgical, nursing, and critical care department of Asan Medical Center. All of the external panelists participated in steps 1-5 of the ADAPTE process between October, 1, 2009 and September, 1, 2010. The panel discussion opened 5 times. Step 6 and the CVI test were conducted between September, 11, 2010 and September, 30, 2010. The researcher explained the study purpose, and provided information about surgical wound care algorithm to 135 critical care nurses, the target population. It took an average 20 minutes to explain and an average 10 minutes for the nurses to fill out the questionnaires. The completed 135 questionnaires were collected via sealed envelopes. Descriptive statistics and SPSS WIN 14.0 (SPSS, Chicago, IL, USA) were used.

## RESULTS

### 1. Defined clinical questions (scope and purpose)

The results of the sorted PICO clinical questions included: P (Patient), critical patient who has surgical wounds; I (Intervention), evidence-based surgical wound care algorithm; C (Comparison), existing domestic or foreign countries local wound care guidelines; and O (Outcome), improving wound recovery.

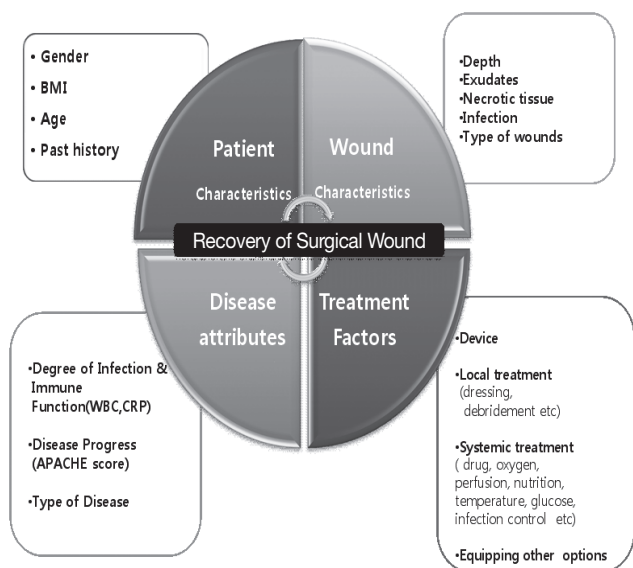
### 2. Search for guidelines and other relevant documents

A study of the essential factors about surgical wound care for critical patients must take precedence in order for searching appropriate guidelines. As a result, there are 9 essential factors for critical wound care. 9 elements for surgical wound management-wound assessment, infection control, necrotic tissue management, wound classification

by exudates and depths, dressing selection, consider systemic factors, wound expected outcome, reevaluate non-healing wound, and special treatment for non-healing wounds-resulted from several studies (Collier, 1996; Field & Kerstein, 1994; Janis, Kwon, & Lalonde, 2010).

This study organized these 9 components into an algorithm framework (Figure 1). Figure 1 shows the relation between patients, diseases, treatment factors, and wound characteristics based on the features and the relevance of a conceptual regression equation about surgical treatment (Mirza et al., 2006).

Six guidelines those meet the 9 components were retrieved from literatures published in 2000-2010. Each should be carried out to eliminate those that are clearly not relevant to the key defined questions. Two guidelines were selected and compared for final approval. The selected wound care algorithms were the 'Solution wound care algorithm (ConvaTec, 2008)' and the 'Bonnie Sue local wound care algorithm (Ruth & Denised, 2007)'. Two of the six guidelines were considered as a draft. This is because other 4 guidelines did not handle the 9 wound care elements, and did not provide sufficient evidence and recommendation levels (Table 1). In contrast, two of the six guidelines were of an algorithm type and suggested more contents compare with other 4 guidelines. However, still, none considered patient systemic factors and critical conditions.



**Figure 1.** The surgical wound care algorithm framework. BMI=Body mass index; WBC=White blood cell; CRP=C-reactive protein; APACHE score=Initial Acute Physiologic and Chronic Health Evaluation that stands for critical ill status of critical patients.

**Table 1.** List of Clinical Practice Guidelines (CPG)

Title	Publisher	End of search date (yr)	Comments
Skin care/wound care algorithm (CPG 1)	Saint Joseph Health System	2008	• Systemic factors are not considered
Solution algorithm (CPG 2)	ConvaTec	2008	• Complex • Systemic factors considered partially, but not specifically mentioned • Level of evidences, strength of recommendations
Bonnie Sue local wound algorithm (CPG 3)	Mosby	2006	• Systemic factors are not considered • Designed for local wound care • Various related to wound care are included
East lancs wound care formulary (CPG4)	East Lancs Drug & Therapeutics Committee	2007	• Systemic factors are not considered
Wound care algorithm (CPG5)	Peterborough Healthcare Wound Management Committee	2004	• Systemic factors are not considered • Focus on pressure ulcer
Smith & Nephew algorithm (CPG 6)	Smith & Nephew	2003	• Systemic factors are not considered

PICO question analysis				
	Population (target objects/target users)	Intervention	Comparison	Outcome
Skin care/wound care algorithm (CPG 1)	Local wound/ Medical doctors & nurses	Local dressing	Not mentioned	Not mentioned
Solution algorithm (CPG 2)	Local wound/ Medical doctors & nurses	Local dressing	Not mentioned	Wound healing
Bonnie Sue local wound algorithm (CPG 3)	Local wound/ Medical doctors & nurses	Local dressing	Not mentioned	Wound healing
East lancs wound care formulary (CPG4)	Local wound/ Medical doctors & nurses	Local dressing	Not mentioned	Not mentioned
Wound care algorithm (CPG5)	Local wound/ Medical doctors & nurses	Local dressing	Not mentioned	Not mentioned
Smith & Nephew algorithm (CPG 6)	Local wound/ Medical doctors & nurses	Local dressing	Not mentioned	Not mentioned

PICO = Patient, intervention, comparison, outcome.

### 3. Screen retrieved guidelines

The screening process used a AGREE and four ADAPTE toolkits to evaluate the existing two guidelines. Both algorithms were evaluated by the expert panelists. The 'Rigour' scores of the AGREE instrument were 62% (Solution algorithm) and 45% (Bonnie Sue algorithm). Since both scores were  $\geq 40\%$ , the quality of each algorithm was appropriate for use in the adaptation. After evaluating the AGREE scores, the expert panel decided whether to choose the guideline, considering its relevance, work burden, clinical context and the given potential time by referring to the ADAPTE toolkit results.

### 4. Selection of guidelines for creating the adapted guidelines

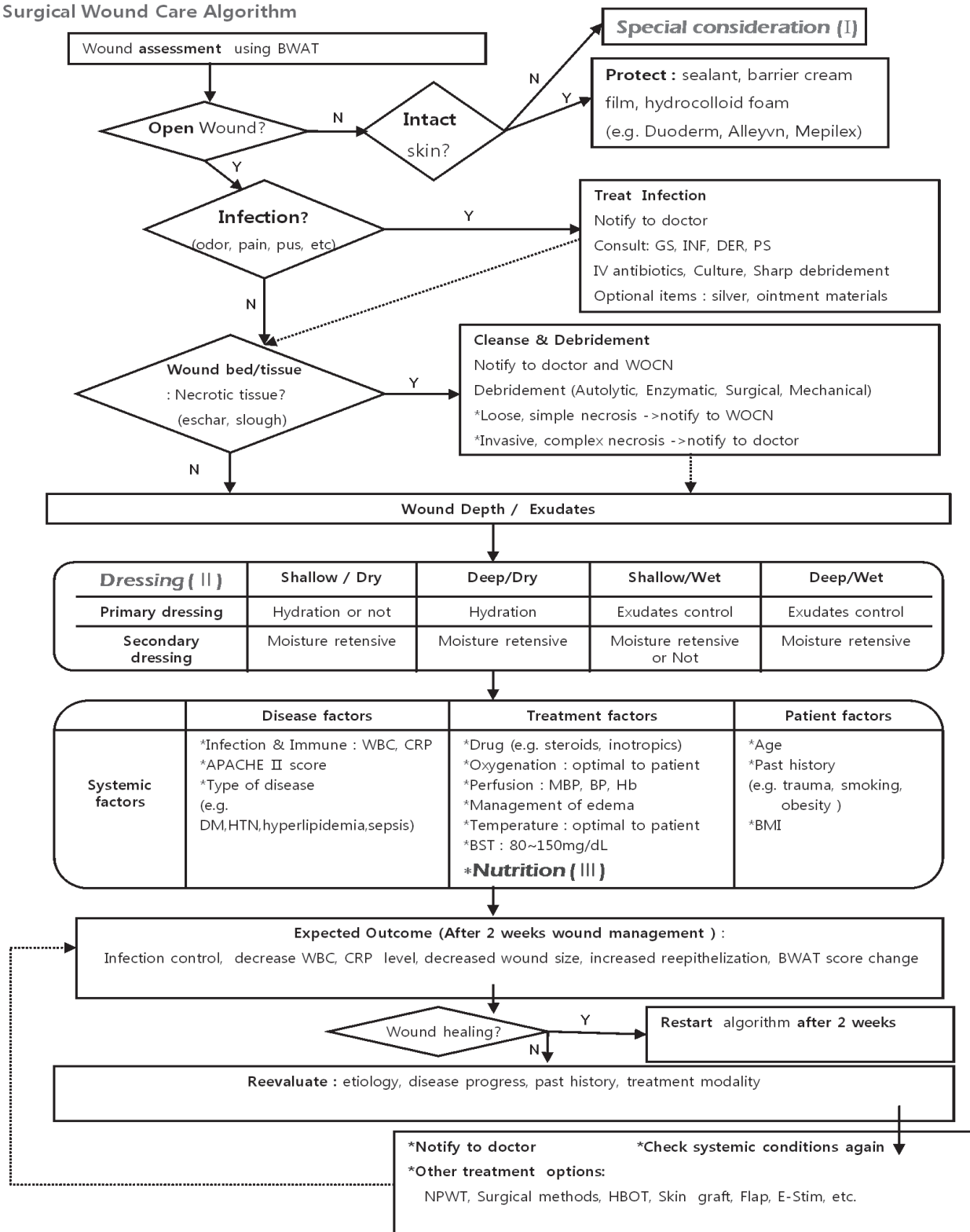
In this study, the expert panelists decided to retain the 'Bonnie Sue local wound care algorithm'. The 'Bonnie Sue local wound care algorithm' was ranked more highly by the 4 toolkits than the 'Solution algorithm' was done. And the experts also preferred the 'Bonnie Sue local wound care algorithm' based on its acceptability, the user level,

and its facilities in application. On the contrary, the 'Solution algorithm' is eight wound care sheets whose implementations are very complex and difficult. As a result, it is judged to be inappropriate for use, and is difficult for a general nurse group to understand. In addition, 'Solution algorithm' is proprietary, and has copyright issues. For these reasons, the expert groups designated the 'Bonnie Sue algorithm' as being the most appropriate.

### 5. Preparation of the draft adapted guideline

The new surgical wound care algorithm was adapted from Bonnie Sue local wound care algorithm with permission from Bonnie Sue. New algorithm included and revised 9 contents compare with Bonnie Sue algorithm. The 9 contents included the following: Wound assessment by BWAT, infection control, necrotic tissue management, wound classification, dressing selections, systemic factors, expected outcomes, reevaluation and other treatment options for delayed wound healing. New algorithm also added some contents like infection control, dressing selections, and systemic factors.

The final wound care algorithm (Figure 2 & Table 2) consists of a

**Surgical Wound Care Algorithm****Figure 2. (A)** Evidence-based surgical wound care algorithm.

GS=General surgery; INF=Infection part; DER=Dermatology; PS=Plastic surgery; WOCN=Wound, ostomy, continence nurse; MBP=Mean blood pressure; BP=Blood pressure; Hb=Hemoglobin; DM=Diabetes mellitus; HTN=Hypertension; BST=Blood sugar test; NPWT=Negative pressure wound therapy; HBOT=Hyperbaric oxygen therapy; E-stim=Electro stimulation; WBC=White blood cell; CRP=C-reactive protein; APACHE=Acute physiologic and chronic health evaluation.

(Continued to the next page)



## Surgical Wound Care Algorithm

### I. Special consideration

- **Intact blister** : disinfect a wound with betadine  
1cc syringe aspiration  
Mepilex or non adhesive allevyn
- **Open blister** : Mepilex or non adhesive allevyn
- **Purple/Bruised skin** : Protect (e.g.sealant or barrier, & Foam or Hydrocolloid)
- **Stable Eschar hands & feets, no exudates** : betadine swab & dry to air  
Protect Mepilex Lite or skin strips  
\*if **exudate or infection** : MD consult
- **Diarrhea** : cleansing, barrier cream (coloplast or Ca-rezz), do not rub.  
Notify to MD: consider Flexi seal, stool Cx, medication

### II.Dressing selection

Deep/Dry	primary	Liquid gel + Hydrofiber (e.g.alginate or keltostat)			Wet gauze	
	secondary	Flim (e.g. OP site or Tegaderm)	Foam (e.g. Mepilex or Allevyn )	Versiva	Hydrocolloid (e.g.duoderm)	
Deep/Wet	primary	Filler (e.g.alginate or aquacel or sorbact filler or keltostat)				
	secondary	Gauze+Film		Adhesive Foam (e.g.Mepilex or Allevyn)	Versiva	
Shallow /Dry	primary	Nothing		Mepitel	Nothing	
	secondary	Flim (e.g. OP site or Tegaderm)		Foam (e.g.Mepilex or Allevyn )	Versiva	Hydrocolloid (e.g.duoderm)
Shallow /Wet	primary	Sorbact filler	Keltostat	Nothing	Alginate	Aquacel
	secondary	Adhesive foam (e.g.Mepilex or Allevyn)		Gauze+Tape(Medix, Op site)		
● If infection : Silver material(e.g. AquaCel Ag) or Sorbact or Furazine gauze or Ointment (e.g. bactroban) apply						

**Figure 2.** (Continued from the previous page) (B) Evidence-based surgical wound care algorithm.  
MD=Medical doctor; Cx=Culture.

(Continued to the next page)

## Surgical Wound Care Algorithm

**III. Nutrition****1. Assessment : MNA –SF tool****2. Considerations**● **Nutrition support status**

- (1) Calories: 35~40 kcal/kg/day (Kg=daily body weight)
- (2) Proteins: 1.2~1.5g/kg/day (consider kidney function)
- (3) Fluids: 30cc/kg/day
- (4) Vitamine C: 500mg~2g/day (e.g. multi vitamin 1g +TPN mix)
- (5) Zinc: 220mg/day for 1-2weeks (normal level: 100mcg/100ml)

● **Nutrition index**

Albumin level: serum prealbumin (15.7-20.6g/dL)  
 serum albumin (3.5-5.0g/dL).

Urine urea nitrogen: 6-17g/day

Total lymphocyte count

How do you think patient's nutrition status related to  
 above nutrition considerations ?

Optimal nutrition ?

Y

N

Keep nutrition status

● **Notify to Doctor**

- > consult: Nutritional Special Team
- > consider external feeding dose, type
- > consider PPN, TPN
- > consider supportive care as like  
 Aminoacid, Lipid, Zinc, Vitamines

● **Other Etiology**

- > check bowel problem:  
 ileus, diarrhea, peritonitis,  
 irritable bowel syndrome, etc.
- > check side effect of drug.

**Figure 2.** (Continued from the previous page) (C) Evidence-based surgical wound care algorithm.

MNA-SF=Mini nutritional assessment short form; PPN=Peripheral parenteral nutrition; TPN= Total parenteral nutrition.

single page sheet with added sheets about details. Closed 'Yes or No' questions were expressed in a triangle, while general suggestions were expressed in rectangles with round corners and interventions were presented in a rectangle. The algorithm started with wound assess-

ment and finished with evaluating wound recovery. It was devised to restart algorithm every 2 weeks.

The flow of these decision making processes (a single sheet, following conditional statements, and continuous flow of suitable shape



**Table 2.** Level of Evidence, Strength of Recommendations of Surgical Wound Care Algorithm

Algorithm contents	Level of evidence	Strength of recommendations
Significance of wound assessment	Level B (moderate)	Grade 1 (strong)
Protection: Barrier cream, sealant, etc	Level B (moderate)	Grade 1 (strong)
Infection control: Antibiotics	Level C (low)	Grade 1 (strong)
Infection control: Silver materials	Level B (moderate)	Grade 1 (strong)
Infection control: Antibiotic ointment	Level C (low)	Grade 2 (weak)
Necrotic tissue management: Debridement	Level C (low)	Autolysis (Grade 1/strong) Enzymatic (Grade 2/weak) Surgical (Grade 1/strong)
Wound classification based on depths, exudates	Level B (moderate)	Grade 1 (strong)
Dressing selections	Level B (moderate)	Grade 1 (strong)
Disease factors related to wound healing *types of disease *immune function: White blood cells (WBC) C-reactive protein (CRP)	Level C (low)	Grade 1 (strong)
Drug related to wound healing (e.g. steroids, inotropics)	Steroids: Level D (very low) Inotropics: Level C (low)	Steroids: Grade 2 (weak) Inotropics: Grade 1 (strong)
Oxygen level related to wound healing	Level C (low)	Grade 2 (weak)
Hemodynamic condition related to wound healing	Level B (moderate)	Grade 2 (weak)
Body temperature related to wound healing	Level B (moderate)	Grade 1 (strong)
Glucose level related to wound healing	Level B (moderate)	Grade 1 (strong)
Nutrition related to wound healing	Level B (moderate)	Grade 1 (strong)
Significance of expected outcomes	Level A (high)	Grade 1 (strong)
Significance of reevaluation	Level A (high)	Grade 1 (strong)
Other treatment options for delayed wound healing	Level A (high)	Grade 1 (strong)

from the beginning to the end) could be effective communication method. This algorithm for critical patients had 3 important elements: Disease, treatment, patient factors. It considered systemic factors such as blood pressure, nutrition, blood sugar, oxygen, hemodynamic disease state, inflammatory status, and basal disease. In particular, with regard to specific elements of the nutritional elements, the algorithm added a extra sheet of MNA-SF to manage nutritional status.

The expected wound healing outcome of this algorithm could be identified using BWAT scores. The total number of points in the BWAT is 65, Scores were analyzed according to classification:  $\geq 60$  points, severely delayed healing; from 14 to 59 points, a borderline between healing and non-healing;  $\leq 13$  points, wound regeneration; and  $\leq 9$  points, wound recovery. Therefore, in this study, the higher the total points, the more the delayed wound healing. In this algorithm, 'Expected outcome of wound healing' was defined as 'on the day BWAT score < 2 weeks ago BWAT score' (Pillen et al., 2010). In addition, related to the wounds healing, the algorithm suggested the wound size, infection with C reactive protein (CRP) levels. Finally, if

a recovery of a wound would have not been improved, other treatment options should were taken into consideration. In these ways, the surgical wound care algorithm can be continuously repeated. Table 3 shows the differences between the Bonnie Sue algorithm and this study's new surgical wound care algorithm.

## 6. External review: CVI test

CVI test including 9 criteria of the surgical wound care algorithm was conducted for 135 critical care nurses with at least 3 years ICU experiences. Mean participants' age was 33.3 years ( $SD \pm 5.2$ ). All of the participants were female with overwhelming education levels: 90% had at least a bachelor's degree, and 83% of them had  $\geq 5$  years of ICU experiences. All of the CVI scores were  $\geq .75$ . The best CVI score (mean 83.6%,  $n = 113$ ) was 'other treatment options at delayed wound healing' and the worst score (75.5%,  $n = 102$ ) was 'necrotic tissue management'.

**Table 3.** Balance Sheet of the Surgical Wound Care Algorithm (Bonnie Sue Local Wound Care Algorithm vs. New Surgical Wound Care)

	Bonnie Sue Local wound care algorithm	New Surgical Wound care algorithm
Suggests wound assessment tool	No	Yes Suggested 'BWAT' tool
States criteria for wound classification	No	Yes Based on exudates and depths
Dressing methods	Complex, hard to understand state 8 dressing methods	Simple, easy (can be applied by staff nurses) Reduce 8 dressing methods to 4 dressing methods based on wound classification
Infection control	Suggest -protect, cleanse, manage odor, treat infection	Supplemental Bonnie Sue's algorithm -add consultation, debridement, local dressing
Considers systemic factors	No	Yes (used for critically ill patients)
States expected outcome	No	Yes (using BWAT scores) (outcomes can be calculated clearly)
Suggests other treatment options for delayed wound healing	No	Yes (appropriate to critically ill patients) (e.g. electro stimulation, hyperbaric oxygen therapy, negative pressure wound therapy, skin graft and so on)
Suggests evidence & strength of recommendations	No	Yes (using GRADE and ADAPTE process)

BWAT = Bates-Jensen Wound Assessment Tool.

## 7. Adoption, dissemination and implementation

A verified evidence-based surgical wound care algorithm using CVI was adopted, disseminated and implemented through leaflets, and web facilities into eight surgical critical care units in general hospitals. The leaders of each unit utilized for these.

## DISCUSSION

There were distinct features those were compared between the new surgical wound care algorithm and the existing wound care guidelines. First, BWAT was applied to wound assessment. Wound assessment precision was elevated through use of BWAT and improved wound healing (Bolton et al., 2004). This finding supported the importance of wound assessment during wound care. Recently, BWAT was the preferred tool among Pressure Ulcer Scale for Healing (PUSH), Acronym of Seven Wound Assessment of Tool (ASEPSIS), and Wound Characteristic Instrument (WCI). PUSH is the best instruments for pressure ulcer, and ASEPSIS, WCI are instruments for surgical wound care. However, BWAT is more specific to surgical wound and can be understood easily by health professionals (Harris et al., 2010). Using BWAT in wound care can create consistency, and accuracy among health professionals to improve the reliability of wound care in critical care units. Second, the algorithm identified the classification standard concerning wound depths and exudates more obviously.

The Solution algorithm identified 5 levels of exudates (less 25%, over 25%, less 75%, over 75%, less 100% of wound surfaces) and Bonnie Sue algorithm identified 4 levels of exudates (no exudates, minimal exudates, moderate exudates, heavy exudates). However, these criteria were not specific and ambiguous. Therefore, this study identified the classification of wound exudates as being 'Wet or Dry' based on the 5 exudates levels in BWAT. 'None, scant, and small exudates of BWAT' were classified as 'Dry' while 'moderate, large exudates of wound surfaces' were classified as 'Wet' in the surgical wound care algorithm. In addition, this study identified the classification of wound depths as being 'Deep or Shallow' based on the 5 depths levels in BWAT. 'Non-blanchable and partial thicknesses' were classified as 'Shallow'. In contrast, 'full thickness with skin loss of various range and obscured by necrosis' were classified as 'Deep' in the surgical wound care algorithm. These clear classifications about wound exudates and depths could make the dressing selection easier than other wound care guidelines and could decrease the uncertain classification about wound exudates and depths. Third, the new surgical wound care algorithm considered the systemic factors of critical ill patients since existing wound care guidelines did not consider them. For consideration and management of the systemic factors when critical care nurses provide wound care, this algorithm included these systemic factors such as immune function, Acute Physiologic and Chronic Health Evaluation (APACHE) scores, oxygen saturation, nutrition, infection, blood glucose, body temperature, and

blood pressure. However, except for nutrition, other systemic components had the limitations that algorithm did not suggest anchor points for systemic factors and they were not connected to the advance treatment flow, suggesting that the anchor points of the systemic factors of wound care have no meaning due to variations depending on the patients' characteristics and environmental situations. It would be better to suggest appropriate criteria depending on each patients' features rather than anchor points (Bowler, 2003).

Consequently, this study expressed the 'appropriate conditions, appropriate dose or appropriate levels' instead of a detailed normal range. It recommend not just analyzing the patient's data itself but the trend of a patient's data for understanding patient's conditions. However, through the results of the literature reviews about blood sugar, '80-150mg/dL' was able to furnish anchor points (Patel, 2008). Based on the systemic factor assessment, the nurses can expect advanced treatments and in-depth understanding of patients. There are advanced treatments such as fluid management, blood transfusions, oxygen therapy (e.g. ventilator, oxygen device), insulin therapy, and drug therapy (e.g. antibiotics, immunosupplements). Therefore, in order to take more advantages of the algorithm in the ICU, the surgical wound care algorithm must be linked to the advance critical care flow in the next study and would need to be supplemented at a later date. This algorithm then repeated the algorithm cycles by reevaluation. If wound healing is delayed, algorithm will suggest the use of other treatment modalities (e.g. hyperbaric oxygen therapy, negative pressure wound therapy, skin graft, skin flap, etc.) and then reevaluation every 2 weeks. Lastly, this algorithm proved level of evidences and strength of recommendations about the 9 contents of the surgical wound care algorithm. These activities were accomplished by the GRADE method. The results of level of evidences were level A (high) with 15.8%, level B (moderate) with 47.4%, level C (low) with 31.6%, and level D (very low) with 5.3%. Level B got the highest. These results assumed previous researches about wounds were enough and there were more case studies than RCTs about surgical wounds care. The strength of recommendations was grade 1 (strong) with 76.2% and grade 2 (weak) with 23.8%.

## 1. Study limitations

There were some limitations during the ADAPTE process. It could not exclude the subjective views of the external panels when they eval-

uated the literature quality, evidences, retrieved guidelines (Wilson, Hayward, Tunis, Bass, & Guyatt, 1995). Therefore, regular revisions and evaluations are needed. Moreover, the outcomes of the surgical wound care algorithm were not yet evaluated. More applications and wound care outcomes of the surgical wound care algorithm must be pressed on the future researches.

## CONCLUSIONS

The surgical wound care algorithm contains 9 criteria that bring about specific features. Compared with the existing wound care guidelines, the new wound care algorithm has more strong points, since it (a) improves precision of wound assessment using BWAT, (b) applies dressing selections to wound more clearly by classification of wound depths and exudates in detail, (c) expands a applicability of the wound care guidelines to critical ill patients, by presenting patients' systemic factors, reevaluation for the non-healing wound, and suggesting other treatment options for non-healing wound, (d) enables follow up wound expected outcomes using BWAT score, and (e) provides the level of evidences and strength of recommendations for specific algorithm contents. This study has a distinct significance from the existing guidelines. This entails the search following evidence-based progress, ADAPTE. It was the first trial research in Korean nursing academic fields that used ADAPTE and was the first trial topic to deal with surgical wound care of critically ill patients. The new surgical wound care algorithm will contribute to the advancement of evidenced based nursing care, will provide high quality practice, and will be expected to be used for nursing intervention in critical care.

## REFERENCES

- ADAPTE collaboration. (2007). *Manual for guideline adaptation, version 1.0*. Retrieved March 10, 2010, from <http://www.adapte.org/www/upload/actualite/pdf/Manual%20&%20Toolkit.pdf>
- Appraisal of Guidelines Research and Evaluation [AGREE] collaboration. (2003). Development and validation of an international appraisal instrument for assessing the quality of clinical practice guidelines: The AGREE project. *Quality & Safety in Health Care*, 12(1), 18-23. doi: 10.1136/qhc.12.1.18
- Bolton, L., McNees, P., van Rijswijk, L., de Leon, J., Lyder, C., Kobza, L., et al. (2004). Wound-healing outcomes using standardized assessment and care in clinical practice. *Journal of Wound, Ostomy, and Continence Nursing*, 31, 65-71.

- Bowler, P. G. (2003). The 10(5) bacterial growth guideline: Reassessing its clinical relevance in wound healing. *Ostomy Wound Management*, 49, 44-53.
- Collier, M. (1996). The principles of optimum wound management. *Nursing Standard*, 10(43), 47-52.
- ConvaTec. (2008). *SOLUTIONS wound care algorithm*. Princeton (NJ): ConvaTec, a Bristol-Myers Squibb Company and National Institutes of Health.
- Courtney, M. (2005). *Evidence for nursing practice*. Marrickville: Churchill Livingstone.
- GRADE Working Group. (2004). Grading quality of evidence and strength of recommendations. *British Medical Journal*, 328, 1490-1494. doi: 10.1136/bmj.328.7454.1490
- Graham, I. D., & Harrison, M. B. (2005). Evaluation and adaptation of clinical practice guidelines. *Evidence-Based Nursing*, 8, 68-72. doi: 10.1136/ebn.8.3.68
- Harris, C., Bates-Jensen, B., Parslow, N., Raizman, R., Singh, M., & Ketchen, R. (2010). Bates-Jensen wound assessment tool: Pictorial guide validation project. *Journal of Wound, Ostomy, and Continence Nursing*, 37, 253-259. doi: 10.1097/WON.0b013e3181d73aab
- Janis, J. E., Kwon, R. K., & Lalonde, D. H. (2010). A practical guide to wound healing. *Plastic Reconstruction Surgery*, 125(6), 230e-244e. doi: 10.1097/PRS.0b013e3181d9a0d1
- Kim, E. S. (2009). *Development and application of blood glucose control protocol in medical ICU patients*. Unpublished doctoral dissertation, Seoul National University, Seoul.
- Lee, E. O., Im, N. Y., Park, H. A., & Lee, I. S. (2009). *Statistical analysis for nursing and medical research*. Seoul: Soomunsa.
- Melnik, B. M., & Fineout-Overholt, E. (2005). *Evidence-based practice in nursing & healthcare: A guide to best practice*. Philadelphia: Lippincott Williams & Wilkins.
- Mirza, K. S., Deyo, R. A., Heagerty, P. J., Turner, J. A., Lee, L. A., & Goodkin, R. (2006). Towards standardized measurement of adverse events in spine surgery: Conceptual model and pilot evaluation. *Biomedical Center Musculoskeletal Disorders*, 7, 53. doi: 10.1186/1471-2474-7-53
- Myers, B. A. (2007). *Wound management: Principles and practice* (2nd ed.). New Jersey: Prentice Hall.
- Patel, K. L. (2008). Impact of tight glucose control on postoperative infection rates and wound healing in cardiac surgery patients. *Journal of Wound, Ostomy & Continence Nursing*, 35(4), 397-404. doi: 10.1097/01.WON.0000326659.47637.d0
- Petzina, R., Hoffmann, J., Navasardyan, A., Malmisjo, M., Stamm, C., Unbehauen, A., et al. (2010). Negative pressure wound therapy for post-sternotomy mediastinitis reduces mortality rate and sternal re-infection rate compared to conventional treatment. *European Journal of Cardiothoracic Surgery*, 38, 110-113. doi: 10.1016/j.ejcts.2010.01.028
- Pillen, H., Miller, M., Thomas, J., Puckridge, P., Sandison, S., & Spark, J. I. (2010). Assessment of wound healing: Validity, reliability and sensitivity of available instruments. *Wound Practice and Research*, 17(4), 208-217.
- Polit, D. F., & Beck, C. T. (2006). The content validity index: Are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health*, 29, 489-497. doi: 10.1002/nur.20147
- Ruth, A. B., & Denised, P. N. (2007). *Acute and chronic wounds: Nursing management* (3rd ed.). St. Louis: Mosby.
- Sheer, B., & Wong, F. K. (2008). The development of advanced nursing practice globally. *Journal of Nursing Scholarship*, 40, 204-211. doi: 10.1111/j.1547-5069.2008.00242.x
- Stevens, J. (1996). *Multivariate statistics for the social sciences* (3rd ed.). NJ: Lawrence Erlbaum.
- Sussman, C. (2007). Tools to measure wound healing. In B. M. Bates Jensen, & C. Sussman (Eds.), *Wound care* (pp. 123-169). Baltimore: Lippincott, Williams & Wilkins.
- William, J. E., Emily, F., Katie, M., & Patricio, M. (2007). Wound healing outcomes: The impact of site of care and patient stratification. *Wounds*, 19, 286-293.
- Wilson, M. C., Hayward, R. S., Tunis, S. R., Bass, E. B., & Guyatt, G. (1995). Users' guides to the medical literature. VIII. How to use clinical practice guidelines. B. what are the recommendations and will they help you in caring for your patients? The evidence-based medicine working group. *Journal of the American Medical Association*, 274, 1630-1632.