Wound management curriculum design and implementation evaluation: Evidence from Peking University First Hospital

CURRENT STATUS: POSTED

Xin Qi 04983@pkufh.com
Peking University First Hospital
Corresponding Author
ORCiD: 0000-0003-1124-2374

Rui He
Peking University First Hospital

Bing Wen
Peking University First Hospital

Qiang Li
Peking University First Hospital

Hongbin Wu
Peking University

DOI:
10.21203/rs.2.15506/v1

SUBJECT AREAS
Internal Medicine Educational Philosophy and Theory

KEYWORDS
Postgraduate education; wound; surgical education; simulation
Abstract

Background: It is of vital importance to standardize wound management knowledge and operations in the early stage of resident training. A simulated wound management curriculum for postgraduate Year 1 surgery residents (PGY1s) was designed and its effectiveness evaluated.

Methods: We used a quasi-experimental method. PGY1s in 2014 constituted the control group, while PGY1s in 2015 and 2016 constituted the intervention group. The traditional curriculum given to the control group comprised a one-hour lecture plus demonstrations by the instructor, followed by a three-hour practice session. Conversely, the curriculum given to the intervention group included a four-hour curriculum with four components. At the end of each year, the wound management curriculum was evaluated.

Results: Subjective assessment showed the intervention group’s scores were significantly higher for dissociation of subcutaneous tissue and quality of suturing and knots. Objective assessment showed there was no obvious improvement in residual marking of incision margin, but the accuracy of debridement depth was greatly improved in the intervention group, the rate of spindle resection decreased and the number of key sutures was significantly higher.

Conclusions: The simulated wound management curriculum for PGY1s revealed a generally satisfactory training outcome. It could be implemented in other Chinese universities.

Background

Traditional surgical resident training has long followed the classical Halstedian teaching model of “see one, do one, teach one” ¹. However, Great changes have taken place regarding the training of surgical residents in China as simulation-based training² and
competence-based medical education\textsuperscript{3} have become widely practiced. Additionally, surgical training now places more weight on technical skills training, simulation, and learning by doing. In the protected training environment of skills labs, residents are able to continually improve their surgical skills through “mistake for giving” \textsuperscript{4} and deliberate practice \textsuperscript{5,6}.

In order to implement the standardized training for surgical residents effectively, Peking University First Hospital (PKUFH) set up surgery school in 2014, which is an important innovation in China\textsuperscript{7}. And for the first time, plastic surgeons replace general surgeons to taking charge of the wound management curriculum. We taught the postgraduate Year 1 surgery residents (PGY1s) in the traditional pattern in 2014, which includes one-hour lecture plus demonstration followed by three-hour practice, but the summative assessment didn’t show a satisfactory results. They can’t handle an irregular wound well in a limited time. Considering wound management is an essential skill for PGY1s, because they often act as the first-line doctors dealing with different kinds of wounds either in the emergency situation or in the ward. Therefore, based on our national conditions, we design a wound management curriculum for PGY1s with reference to the US experiences, which basically covers the core skills listed in the US surgical curriculum\textsuperscript{8}. The curriculum was applied since 2015, and this study was carried out to evaluate the effectiveness of this new pattern of wound management curriculum.

Methods

Study design

The wound management curriculum took place during the fourth month of standardized resident training. It covered surgical skills such as making incisions, tissue protection, tissue dissociation, suturing, and local skin flaps, among others. PGY1s in 2014
constituted the control group, while PGY1s in 2015 and 2016 constituted the intervention group. The same teaching contents were given to both groups but in different patterns. At the end of the first year (seven months after the wound management curriculum), the skills of PGY1s were assessed, and the curriculum was evaluated. All the PGY1s were tested on irregular wound repair (debridement and suture). The assessment criteria were the same for each group of PGY1s, and the test content and scoring criteria were not known to PGY1s beforehand. In the test, an irregular area of $10 \times 3.8 \text{ cm}^2$ was marked on cadaveric pork belly skin (Fig. 1A), representing tissue necrosis down to/affecting the deep fascia. PGY1s were required to perform a primary suture after debridement within 15 minutes. Key suture numbers and dog ear treatment were showed in Fig. 1.

Irregular wound debridement and suture test (from one of the residents). A. the irregular area marked on cadaveric pork belly skin; B. the appearance of the wound after debridement; C. the key suture numbers (the red box) and dog ear treatment (the blue circle).

The examiners included one plastic surgery attending and two general surgery attending, they would receive a brief training by the instructor before the test. They had to make both a subjective and objective assessment of the PGY1s’ technical skills of wound debridement and closure. A global rating scale (GRS) was used to assess the performance from six dimensions, namely, “maintaining a sterile field,” “knowledge and handling of instrument,” “quality of excision,” “quality of debridement,” “dissociation of subcutaneous tissue,” and “quality of suturing and knots,” and each dimension was assessed on a 10-point scale, the internal consistency reliability turned out to be acceptable. The objective assessment included key suture numbers, residual necrotic tissue condition, resection depth, and dog ear treatment. The average score was calculated as the final
score. The instructor remained the same person during three years, which was one of the correspond authors.

**Control group**

In 2014, the curriculum was arranged as a one-hour lecture plus demonstration followed by three-hour practice session for PGY1s. Feedback was given in the end. The teaching materials were rabbits under general anesthesia.

**Intervention group**

In 2015 and 2016, the curriculum was conducted as a four-component pilot study with a four-hour curriculum: pretest, didactic teaching, basic surgical skills, and reparation and reconstruction. The teaching materials were cadaveric pork belly skin. The four components were as follows:

**Component 1: Pretest - Baseline surgical skills assessment (10 mins)**

Before beginning any teaching, PGY1s were given a pretest to assess their surgical skills so that the curriculum content could be adjusted to their educational needs. The necrotic area was marked on cadaveric pork belly skin (see the black area in Fig. 2A). PGY1s were required to perform a complete excision of the lesion and primary closure of the wound. The recommended procedure is shown in Fig. 1. PGY1s were expected to leave flap a and b open (Fig 2B) and suture the two key points—point c to point a and point b to point d (Figure 2C)—to close the wound. The instructor was required to observe PGY1s’ operation procedure, focusing on wound debridement and closure.

[Fig.2 here]

Baseline surgical skills assessment. A. the schematic of the necrotic area on cadaveric pork belly skin; B. the recommended closure; C. two key points; D. the schematic of spindle resection; E. the schematic of another inappropriate closure.
Component 2: Didactic teaching on conception of debridement and low tension closure (60 mins)

Based on the pretest results, the instructor covered topics related to wound debridement and closure, including incision selection, respect for tissue, debridement scope and level, dissociation and suturing of subcutaneous tissue, suture methods and techniques, and the like. Then, PGY1s were asked to restart or proceed with the wound debridement and closure according to their individual performances in the pretest.

Component 3: Basic surgical skills (80 mins)

In this part of the curriculum, PGY1s were expected to complete the closure of round, square, and triangular wounds. Using a modified version of Peyton’s Four-Step Approach\textsuperscript{11}, the instructor offered basic surgical skills training (excision, suturing, knot-tying, etc.) in the form of small group teaching with a focus on deconstruction and comprehension\textsuperscript{12}. Deliberate practice\textsuperscript{13} was required of the students to reinforce correct operational habits. The instructor inspected PGY1s’ wound closure process and prepared for Component 4.

Component 4: Reparation and reconstruction (90 mins)

Instructor and PGY1s worked together to reflect on their acquired knowledge and progress in wound closure, with instructor providing feedback and explaining basic local flap principles and concepts. In addition, PGY1s learned about aesthetic issues such as dog ear in their surgical maneuvers, respect for tissue, and wound reparation and reconstruction. In terms of surgical practice, PGY1s completed round, square, and triangular wound closures if it had not been finished in component 3. Some PGY1s who exhibited a higher skill level were given individualized surgical tasks involving more complex wounds. The training in 2015 and 2016 followed the same four-component approach, but we
dynamically adjusted the content and proportion of each component according to the pretest results and the summative assessment from the previous year (see Fig. 3).

[Fig.3 here]

Course design flowchart

Statistical analysis

All results were expressed as mean and standard deviation in the form of mean±SD. The data were statistically analyzed using the t-test, least significant difference test, and Kolmogorov-Smirnov statistic, and linear correlation, using SPSS 22.0 software (IBM Corporation, USA). A p-value of less than 0.05 was regarded as statistically significant.

Results

Participants

The number of participants in 2014, 2015 and 2019 are 31, 39, and 37, respectively (Table 1). There was no significant difference in the age of PGY1s trained in the years 2014, 2015, and 2016 (p = 0.295, F = 1.235).

Pretest

All PGY1s in 2015 and 2016 were supposed to take the pretest, but a few PGY1s missed it for being late due to the surgeries or other clinical things. The results indicated that the wound closure performance of PGY1s trained in 2015 (2015 PGY1s hereinafter) were better than that of PGY1s trained in 2016 (2016 PGY1s hereinafter), and spindle resection was significantly less observed in 2015 PGY1s than in 2016 PGY1s (Table 2).

Subjective assessment

The results indicate an GRS scores of PGY1s presented an increasing trend in scores over the three years. The scores of 2015 and 2016 PGY1s were significantly higher than those of 2014 PGY1s for the dimensions of “dissociation of subcutaneous tissue” and “quality of suturing and knots.” None of the 2014 PGY1s performed dissociation of subcutaneous
tissue, so they scored zero on this dimension. Based on the assessment results in 2015, we reinforced training for “quality of debridement” and “dissociation of subcutaneous tissue” for 2016 PGY1s, leading to the significant improvement of GRS scores. (See Table 3 and Fig. 4)

Subjective assessment results of postgraduate Year 1 surgery residents over the three years.

**Objective assessment**

Compared with 2014, PGY1s in 2015 and 2016 showed no obvious improvement in residual marking of incision margin (Table 4), but their accuracy of debridement depth was greatly improved, and the rate of spindle resection decreased. However, with the decrease of incision tension, PGY1s would close the wound as soon as possible and not choose subcutaneous suture. Starting in 2016, PGY1s were taught to take care to avoid creating dog ears during wound treatment. Table 5 showed that the number of key sutures was also found to be significantly higher in 2015 and 2016 PGY1s than in 2014 PGY1s.

**Discussion**

PGY1s’ response when faced with actual, real-life wound management could be better assessed by simulating emergencies, adding complex examination questions, including time pressure, and using a more sophisticated environment. Feedback after training, as well as the cultivation of surgical conception, might contribute to PGY1s’ skill acquisition and retention. The results of summative assessment seven months after the training showed that the proposed curriculum can help students retain technical skills, which suggested an appropriate curriculum design may accelerate the transformation of technical skills in the lab into core competency.

Generally, when medical students graduate, their competence and confidence in common
medical procedures is lacking\textsuperscript{16}. Moreover, the traditional approach presents a barrier to effective learning\textsuperscript{17}. Wounds usually occur in emergency situations, which are unpredictable and often relatively complicated. Wound management in these cases usually falls into two categories: debridement and closure. Debridement includes respect for tissue, excision/dissection, clearance range, and dissociation, all of which are reflected in the subjective assessment dimensions 3 (quality of excision) and 4 (quality of debridement) and the objective assessment criteria of margin of incision without residual markers, debridement depth to deep fascia, and spindle resection. Meanwhile, closure includes low tension closure, stitching skills and techniques, and aesthetics, which involve the subjective assessment dimensions 5 (dissociation of subcutaneous tissue) and 6 (quality of suturing and knots) and the objective assessment criteria of key suture numbers, subcutaneous suture, and dog ear treatment. For 2015 and 2016 PGY1s, both subjective and objective assessment of their surgical skills were significantly improved as compared with 2014 PGY1s, indicating that the change of curriculum design and content can effectively improve PGY1s’ technical skills.

Although the resident admission criteria of our hospital basically stays the same every year, residents\textsuperscript{18}, fellows\textsuperscript{19}, and senior attending physicians\textsuperscript{20} have extreme variability in skills. This phenomenon was also revealed in the pretest results, which showed that 2016 PGY1s’ basic understanding of wound management was relatively inadequate as compared to 2015 PGY1s. In light of this information, we had to dynamically adjust the teaching content of the curriculum. In 2015, more time was allotted for the training of repair and reconstruction skills, whereas in 2016, we completed the predetermined teaching content, leaving more time for the explanation of basic concepts. At the same time, based on the summative assessment results in 2015, we reinforced the training of technical skills in
efficient debridement and incision tension reduction for 2016 PGY1s. The overall ability of 2016 PGY1s was significantly improved compared with 2015 PGY1s. They even had time to attempt dog ear treatment. As a result of this dynamic, tailored design, the curriculum improves as an ongoing cycle.

Some medical educators believe that the traditional training approach is unsuitable for effective learning. However, with the wide application of simulation training in China, there is also a growing trend of overdependence on new equipment and high simulation, ignoring the advantages of the traditional approach, which utilizes cheap, convenient, and reusable teaching materials. In 2014, we chose living rabbits as the teaching material for the sake of high simulation, but the multi-function of the material interfered with the fulfillment of the real teaching purpose. Therefore, we returned to the traditional, single-purpose material—cadaveric pork belly skin—in 2015 and 2016, focusing on the development of PGY1s' surgical technical skills and operational thinking progress. Through the adjustment of teaching content and methods, and in line with the needs of PGY1s, instructors could effectively control the training pace and guide the active learning of PGY1s. Furthermore, the replacement of teaching materials can effectively reduce the cost of training and the difficulty of preparation, thus promoting the applicability of the curriculums in other training settings.

Despite the confidentiality of the test questions, the same test questions were used for three consecutive years, which could reduce test efficacy. In addition, mastery learning would be more suitable for the assessment of the curriculum, but ReMERM was not referred to at the beginning of the curriculum design.

Conclusion

PKUFH designed a simulated wound management curriculum for PGY1s, which revealed a generally satisfactory training outcome. It filled a gap in current research in China and
could be implemented in other Chinese universities. Some desirable curriculum design practices could be learned from this training process: teaching materials must be carefully chosen; teaching content and methods have to be adjusted in line with trainees’ pretest results; and trainees have to be provided with opportunities for individualized feedback/debriefing and deliberate practice. All these practices will be of great help for the development of PGY1s’ technical skills.

List Of Abbreviations

PGY1s: postgraduate Year 1 surgery residents
PKUFH: Peking University First Hospital
GRS: global rating scale
SD: standard deviation
ReMERM: Reporting Mastery Education Research in Medicine

Declarations

Ethics approval and consent to participate
The study was approved by Peking University First Hospital Ethics Committee. The consent was unnecessary in this study and the ethics committee approved this point.

Consent for publication
Not applicable.

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors report no conflicts of interest.

Funding
This work was supported by Project of Medical Education Research from Medical Education Branch of Chinese Medical Association & Medical Education Professional Committee of China Association of Higher Education (2018B-N05035); National Natural Science Foundation of China for Young Scholars (71804005). The both funding supported the financial and administrative affairs regarding study design, data collection, and statistical analyses.

Authors’ contributions
XQ and QL designed the curriculum, XQ and RH collected the data, did statistical analysis and wrote the manuscript, XQ and HB W formulated the research idea and critically edited the draft of the paper. BW supervised the whole work and revised the manuscript. All authors approved the final manuscript.

Acknowledgments
The authors wish to thank Haichao Li, Ying Wang and Yan Li for their supports; Qian Lu and Huaqin Cheng for their advices.

References
1. Acton RD. The evolving role of simulation in teaching surgery in undergraduate medical education. Surg Clin North Am. 2015; 95(4): 739-750.
2. Willis RE, Van Sickle KR. Current status of simulation-based training in graduate medical education. Surg Clin North Am. 2015; 95(4): 767-779.
3. Li HC, Wang C. Reform direction of medical education in China: implementing “competency-based” medical education. Chin Med J (Engl). 2013; 126(17): 3203-3204.
4. Ziv A, Ben-David S, Ziv M. Simulation based medical education: an opportunity to learn from errors. Med Teach. 2005; 27(3): 193-199.
5. Ericsson KA. Deliberate practice and acquisition of expert performance: a general overview. Acad Emerg Med. 2008; 15(11): 988-994.
6. McGaghie WC, Issenberg SB, Cohen ER, et al. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. Acad Med. 2011; 86(6): 706-711.

7. Qi X, Li Y, Li HC, et al. A preliminary study on the role of surgery school the standardized training of surgical residents. Chin J Med Edu. 2016; 36(5): 764-767.

8. ACS/APDS surgery resident skills curriculum. American College of Surgeons. 2014. https://www.facs.org/education/program/apds-resident. Accessed 5 May 2014.

9. Hopmans CJ, den Hoed PT, van der laan L, et al. Assessment of surgery residents’ operative skills in the operating theater using a modified Objective Structured Assessment of Technical Skills (OSATS): a prospective multicenter study. Surgery. 2014; 156(5): 1078-1088.

10. Qi X, Li N, Liu S, et al. Research on continuous improvement of objective structured clinical examination in standardized training of postgraduate year 1 surgery residents. Chin J Med Edu. 2017; 37(3): 457-461.

11. Nikendei C, Huber J, Stiepak J, et al. Modification of Peyton’s four-step approach for small group teaching—a descriptive study. BMC Med Educ. 2014; 14: 68.

12. Krautter M, Weyrich P, Schultz JH, et al. Effects of Peyton’s four-step approach on objective performance measures in technical skills training: a controlled trial. Teach Learn Med. 2011; 23(3): 244-250.

13. Ericsson KA, Krampe RT, Teschromer C. The role of deliberate practice in the acquisition of expert performance. Psychol Rev. 1993; 100(3): 363-406.

14. Qi X, Liu ZB, Li HC, et al. Implementation and evaluation of objective structured clinical examination for Postgraduate Year 1 surgery residents. Chin J Med Edu Res. 2017; 16(1): 12-16.

15. Siroen KL, Ward CDW, Escoto A, et al. Mastery Learning- does the method of learning
make a difference in skills acquisition for robotic surgery? Int J Med Robotics Comput Assist Surg. 2017; e1828. https://doi.org/10.1002/rcs.1828

16. Promes SB, Chudgar SM, Grochowski CO, et al. Gaps in procedural experience and competency in medical school graduates. Acad Emerg Med. 2009;16(s2): S58-S62.

17. Bandiera G, Lee S, Tiberius R. 2005. Creating effective learning in today’s emergency departments: how accomplished teachers get it done. Annals of Emergency Medicine. 2005; 45(3): 253-261.

18. Barsuk JH, Cohen ER, Caprio T, et al. Simulation-based education with mastery learning improves residents’ lumbar puncture skills. Neurology. 2012; 79(2): 132-137.

19. Barsuk JH, Ahya SN, Cohen ER, et al. 2009. Mastery learning of temporary hemodialysis catheter insertion by nephrology fellows using simulation technology and deliberate practice. Am J Kidney Dis. 2009; 54(1): 70-76.

20. Birkmeyer JD, Finks JF, O’Reilly A, et al. Surgical skill and complication rates after bariatric surgery. N Engl J Med. 2013; 369(15): 1434-1442.

Tables

Table 1. Demographic information of postgraduate Year 1 surgery residents trained 2014-2016

| Year | Total Number (n) | Male (n) | Female (n) | Average Age (y) | p   |
|------|------------------|---------|------------|----------------|-----|
| 2014 | 31               | 30      | 1          | 24.94±1.67     | 0.295|
| 2015 | 39               | 36      | 3          | 24.95±1.16     |      |
| 2016 | 37               | 35      | 2          | 25.46±1.94     |      |

Table 2. Pretest results of postgraduate Year 1 surgery residents trained in 2015 and 2016

| Year | Total number of residents (n) | C [% (n)] | D [% (n)] | E [% (n)] | Wound closure [% (n)] |
|------|------------------------------|----------|-----------|-----------|-----------------------|
| 2015 | 34                           | 47.0(16) | 11.8(4)   | 41.2(14)  | 11.8(4)               |
| 2016 | 30                           | 10.0(3)  | 43.3(13)  | 46.7(14)  | 0(0)                  |

Note: C: local flap transfer; D: spindle resection; E: necrosis resection, aimless and
## Table 3. Comparison of the results of subjective assessment

| Dimension                           | Mean          | p            |
|-------------------------------------|---------------|--------------|
|                                     | 2014 n=31     | 2015 n=39    | 2016 n=37    | 2014 vs. 2015 | 2014 vs. 2016 |
| 1. Maintaining a sterile field      | 7.53±0.72     | 7.68±1.20    | 7.79±0.32    | 0.524         | 0.048*         |
| 2. Knowledge and handling of instrument | 7.63±0.90     | 8.03±0.51    | 7.85±0.51    | 0.022*        | 0.224          |
| 3. Quality of excision              | 7.59±0.79     | 7.61±0.82    | 7.87±0.51    | 0.936         | 0.091          |
| 4. Quality of debridement           | 7.12±1.33     | 7.47±0.95    | 7.89±0.56    | 0.222         | 0.005**        |
| 5. Dissociation of subcutaneous tissue | 0.00         | 5.82±2.67    | 7.52±0.77    | <0.001**      | <0.001**       |
| 6. Quality of suturing and knots    | 7.03±1.19     | 7.54±0.72    | 7.71±0.83    | 0.043*        | 0.010*         |
| Global rating scale                 | 36.91±3.29    | 44.15±4.52   | 46.64±2.36   | <0.001**      | <0.001**       |

Note: *: p<0.05; **: p<0.01

## Table 4. Objective assessment results of postgraduate Year 1 surgery residents in the three years
| Year      | Residual marking of incision margin (n (%)) | Depth to deep fascia (n (%)) | Spindle resection (n (%)) | Dog ear treatment (n (%)) | Subcutaneous suture (n (%)) |
|-----------|--------------------------------------------|------------------------------|--------------------------|---------------------------|----------------------------|
| 2014 (n=31) | 7 (22.6)                                   | 7 (22.6)                     | 8 (25.8)                 | 0 (0.0)                   | 14 (45.2)                  |
| 2015 (n=39) | 12 (30.8)                                  | 30 (76.9)                    | 1 (2.6)                  | 0 (0.0)                   | 6 (15.4)                   |
| 2016 (n=37) | 11 (29.7)                                  | 27 (73.0)                    | 3 (8.1)                  | 5 (13.5)                  | 7 (18.9)                   |

Table 5. Comparison of key suture numbers

| Key suture numbers | Median number (min, max) | 2014 n=31 | 2015 n=39 | 2016 n=37 | 2014 vs. 2015 | 2014 vs. 2016 |
|--------------------|--------------------------|-----------|-----------|-----------|----------------|----------------|
|                    |                          | 1(0,4)    | 3(0,4)    | 3(0,4)    | 0.002**        | 0.005**        |

Note: *: p<0.05; **: p<0.01

Figures

Figure 1

Irregular wound debridement and suture test (from one of the residents). A. the irregular area marked on cadaveric pork belly skin; B. the appearance of the wound after debridement; C. the key suture numbers (the red box) and dog ear treatment (the blue circle).
Baseline surgical skills assessment. A. the schematic of the necrotic area on cadaveric pork belly skin; B. the recommended closure; C. two key points; D. the schematic of spindle resection; E. the schematic of another inappropriate closure.
Subjective assessment results of postgraduate Year 1 surgery residents over the three years.