Early Complications Following Facial Laceration Repair Performed by Emergency Physicians After One Year of Wound Closure Training

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ABSTRACT

Objective: Facial lacerations, which are common in the emergency department, have usually been repaired by non-facial trauma specialists, such as emergency physicians. Given the ongoing discussion regarding quality assurance or the optimal training model on facial laceration repair for nonspecialists, we sought to determine the impact of a 1-year wound closure training provided to emergency physicians. We hypothesized a decrease in early complications following facial wound closure after the training.

Methods: A retrospective observational study was conducted between 2013 and 2015 at an academic center. We included patients with isolated facial lacerations that were repaired by emergency physicians and reviewed by board-certified plastic surgeons during a follow-up visit. Patients whose wounds were not reviewed within 3 days were excluded. The 1-year training curriculum, which consisted of several sessions of lecture, hands-on practice, and case review, had been developed by a multidisciplinary team and provided to emergency physicians. Patient data were divided between nonparticipant and participant groups, and a propensity score was developed to estimate the probability of being assigned to the participant group. The incidence of early complications, defined as the need for additional suturing or resuturing due to wound dehiscence, was compared among the groups after propensity score matching.

Results: Although 132 patients satisfied all the inclusion criteria, 11 were excluded due to delayed initial wound review. Among the 70 patients who were eventually included in the participant group, 40 were matched with those in the nonparticipant group. The incidence of early complications was significantly lower in the participant group than in the nonparticipant group (5.0% vs. 20.0%, odds ratio = 0.21, 95% confidence interval = 0.07–0.61, $p = 0.04$).

Conclusions: The 1-year training provided to emergency physicians reduced the incidence of early complications following facial laceration repair. Accordingly, future wound closure training models should consider the 1-year training curriculum presented herein.

Facial lacerations, which are among the common injuries presented to the emergency department (ED), warrant optimal wound repair skills for favorable outcomes.^{1,2} Since short-term complications, such as wound dehiscence, skin necrosis, and wound infection, can impair wound healing and eventually

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result in long-term cosmetic problems, facial laceration repair should be performed with appropriate wound closure methods chosen by a judicious wound evaluation.^{3,4}

Although patients may prefer facial trauma specialists, such as plastic surgeons, oral and maxillofacial surgeons, or otolaryngology/head and neck surgeons, to close their facial wounds to obtain the best possible outcome, the distribution of facial trauma coverage by specialists at the ED is regionally dependent.⁵ Studies have shown that a considerable number of facial wounds were repaired by nonspecialists, including emergency physicians, general surgeons, and registered nurses.^{3,6–8} A 2015 retrospective observational study of patients with facial lacerations found that more than 70% of patients underwent repair by a nonspecialist.³ Another case review of facial wounds in the United Kingdom reported that approximately half of the lacerations were closed by middle-grade physicians and nurse practitioners.⁷

Facial trauma nonspecialists have no available standard protocols regarding the management of facial lacerations,^{2,9} and patterns of patient referral to specialty services are also reported to vary, according to physician preferences and protocols between different institutions.¹⁰ In 2006, a survey regarding the management of facial lacerations by emergency physicians identified a considerable variety of practices including wound closure methods, preferred suture material, antibiotic therapies, and specialist referral.⁶ In another survey within the United States, only 61% of emergency or trauma services at teaching hospitals claimed to have a protocol in place for referral of patients with facial injuries.⁵ Some plastic surgeons also acknowledged an inadequate selection of wound closure methods by emergency physicians with 4% only of facial laceration cases being referred to facial trauma specialists.¹¹

Despite the extensive number of facial wounds being repaired by nonspecialists and the wide variety in practice management, studies investigating complications after facial wound closure performed by nonspecialists are generally lacking. In 1994, a study on pediatric dermal lacerations, including facial injuries revealed that nurses who completed a standardized training program in wound management were capable of definitive care based on a survey of parent satisfaction.⁷ However, a 2015 survey found that pediatric patients reported significant dissatisfaction after facial wound closure by an emergency physician,³ which

concerns the quality assurance of facial laceration repair by nonspecialists. Another prospective study at a pediatric ED in the United States showed that 8.2% of simple and small superficial facial lacerations repaired by nonspecialists had complications at short-term follow-up,¹² which is a higher incidence than for facial trauma specialists (1.4%–5.2%) reported in previous studies.^{1,13,14}

Furthermore, discussions regarding the type and frequency of wound closure training for facial trauma nonspecialists are ongoing.^{3,7,15,16} Although the vast majority of facial trauma specialists establish their skills during their validated curricula, their training typically extends to daily practice and continues through the years. Thus, a new training model for nonspecialists should be developed and examined with a high-quality objective evaluation. Since emergency physicians are more frequently exposed to facial lacerations at EDs compared to other facial trauma nonspecialties, such as general surgeons or trauma surgeons, the training curricula that emergency physicians could use to acquire sufficient skills for performing facial wound closure should be effective across other EDs. We developed a 1-year wound closure training curriculum for emergency physicians, in which educational goals were separately determined based on each provider status (intern, resident, or board-certified emergency physician) and sought to determine the impact of training on favorable outcomes of facial laceration repair performed by emergency physicians. We hypothesized that early complications following facial wound closure, defined as wounds that needed additional suturing or resuturing, would decrease after providing 1 year of training to emergency physicians.

METHODS

Study Design

This retrospective observational study was conducted between January 2013 and June 2015 at an academic center after being reviewed and approved by the Institutional Review Board for the Conduct of Human Research.

Study Setting and Population

We retrospectively identified patients with isolated facial injuries who were transported by ambulance to the ED of our academic center during the study period. Walk-in patients were not subjected in this study because all walk-in patients with facial lacerations were

treated by facial trauma specialists at our ED. Patients who satisfied the following criteria were included: facial lacerations were closed by emergency physicians, referral to plastic surgeons responsible for facial trauma in our ED was not requested at the ED, and wound review was performed by board-certified plastic surgeons during a follow-up visit and medical chart for wound review was available. Patients whose wounds had not been reviewed within 3 days after wound closure were excluded, since the initial wound review by a specialist within 3 days was recommended in our hospital policy and wound dehiscence is usually diagnosed in the first week.^{1,3,12–14} Also excluded were patients with facial injuries who visited our ED more than once during the study period.

Study Protocol

Emergency Physicians and Wound Closure Practice at Our ED. Each board-certified emergency physician had completed different residency programs at several institutions. Our emergency medicine residency program comprises 4 years, not counting intern year (postgraduate year 3 to 6 residents; PGY-3s to -6s) and interns (PGY-1s and -2s) came from several specialties based on their rotation schedule and remained at our ED for 3 months.

Prior to the initiation of the study, interns and residents had encountered a couple of facial lacerations a day in daily practice, and hence were accustomed to closing wounds. They had performed wound evaluation and closure under the supervision of board-certified emergency physicians who had been already capable of basic wound closure prior to the development of the training curriculum. This wound closure practice and the distribution of each provider status

(intern, resident, or board-certified emergency physician) at our ED remained throughout the study period.

Training Curriculum Development. As a quality improvement project, 1-year wound closure training for emergency physicians had been developed by the multidisciplinary quality improvement team, using a logic model (Table 1).

Major issues and general needs were surveyed through questionnaire answered by emergency physicians and plastic surgeons and identified as the high incidence of wound dehiscence that needed additional suturing or resuturing. Accordingly, a targeted goal of training was set as the acquisition of sufficient proficiency in performing facial wound closure.

The educational goal of each provider status was based on providers' experience prior to the study as follows: interns and residents would acquire sufficient skills in facial wound closure and basic knowledge of facial lacerations, and board-certified emergency physicians would exhibit optimal evaluation of facial wounds and develop effective skills in teaching facial wound closure methods to interns and residents.

Wound Closure Training. The training curriculum consisted of lectures, hands-on practice, and case reviews on facial laceration repair after the assessment of wound closure (Table 2). Attendance at each training session was recorded by date and by signature and was confirmed prior to the analyses.

The half-hour lecture incorporated basic concepts of wound closure, characteristics of wound closure methods, favorable suture materials for facial laceration repair, and evaluation of complicated facial lacerations.

Table 1
Training Curriculum Development With Logic Model

Input	Emergency physicians,* plastic surgeons	
Activities†	Emergency physicians*	Participate in training sessions (lecture, hands on, and morbidity conference)
	Plastic surgeons	Present the lecture
		Provide case review
Outputs	Interns and residents	Acquire adequate skills in facial wound closure
		Gain basic knowledge of facial lacerations
	Board-certified emergency physicians	Provide optimal evaluation of facial wounds
		Demonstrate effective abilities in teaching facial wound closure methods to interns and residents
Outcomes	Improve quality of facial wound management among emergency physicians*	

*Emergency physicians include interns, residents, and board-certified emergency physicians.

†Details are shown in Table 2.

Table 2
One-year Wound Closure Training Curriculum

Lecture	Instructor	Plastic surgeon (board-certified)
	Trainee	Emergency physicians*
	Contents	Basic concepts of wound closure, characteristics of wound closure methods, favorable suture materials for facial laceration repair, and evaluation of complicated facial lacerations
	Schedule	Half-hour, at least every 3 months
	Attendance	Everyone attended four times a year
Hands-on	Instructor	Board-certified emergency physician (supervised by trauma surgery fellow)
	Trainee	Interns and residents
	Contents	Wound approximation on training skin pads, simple interrupted epidermis suturing with 5-0/6-0 nonabsorbable sutures and buried dermal suturing with 4-0/5-0 absorbable sutures
	Schedule	2 hours, every 3 months
	Attendance	Interns and residents participated at least once a year, [†] board-certified emergency physicians taught twice a year
Case Review	Instructor	Plastic surgeons (board-certified)
	Trainee	Emergency physicians*
	Contents [‡]	All complications were discussed in the morbidity conference
	Schedule	1–2 hours, every 3 months
	Attendance	Everyone attended four times a year

*Emergency physicians include interns, residents, and board-certified emergency physicians.

[†]Interns had additional short-time training (<15 min) supervised by residents every week for 3 months.

[‡]Additional case review was provided by board-certified plastic surgeons as needed.

The lectures were presented by one board-certified plastic surgeon, and each physician attended the lectures at least four times during the 1-year training period.

During the 2-hour hands-on practice sessions, interns and residents performed wound approximation on suture training skin pads while being instructed by board-certified emergency physicians. Trauma surgery fellows supervised the hands-on sessions to ensure the quality of surgical skill teaching. Interns and residents subsequently learned simple interrupted epidermis suturing with 5-0/6-0 nonabsorbable sutures, as well as buried dermal suturing with 4-0/5-0 absorbable sutures. The teacher-to-intern or teacher-to-resident ratio was 1:6 during the hands-on practice session, which was conducted every 3 months. Each intern or resident attended the hands-on practice session at least once, and every intern had additional short-time training (<15 min) supervised by residents every week for 3 months. Each board-certified emergency physician instructed the interns and residents in the hands-on sessions at least twice during the training.

A board-certified plastic surgeon provided a case review to each physician who performed wound repair in some of the cases. Moreover, cases that needed additional suturing or resuturing were discussed in the morbidity conference conducted every 3 months,

which was attended by all emergency physicians and a plastic surgeon.

Training Implementation. The 1 year of wound training was initiated at our academic center's ED in April 2013. A total of 15 board-certified emergency physicians, 21 residents, and 78 interns underwent the 1-year training program.

Considering that the wound closure training had been initiated as a quality improvement project, the training curriculum was continued even after the initial 1-year training was completed in March 2014. Accordingly, two board-certified emergency physicians and four residents wishing to participate in further training attended the lectures and the morbidity conferences in the following year and thereafter. No emergency physician repeated the hands-on training.

Wound Review. Based on our hospital policy, the patients were instructed to present their wounds to board-certified plastic surgeons within 3 days of facial laceration repair by emergency physicians. Wound review was performed by board-certified plastic surgeons blinded to the study hypothesis, study group assignment, and physicians who had repaired wounds. Complications were diagnosed based on each plastic surgeon's assessment, and additional repairs were performed as needed during follow-up visits and recorded

in the medical records. One of the plastic surgeons performing the wound review also presented the lecture, which was part of the training curriculum.

Chart Review. Patient information was extracted by reviewing each patient's hospital record. The chart review was performed by two authors blinded to the study hypothesis and study group assignment, after the inter-rater agreement had been assessed by having a sample of charts reviewed independently by these two authors. Conflicting and/or ambiguous chart elements were coded as missing data.

Measures

The primary outcome was early complications, defined as wound dehiscence that needed additional suturing or resuturing upon initial wound review. The number of wounds that needed additional suturing or resuturing was measured via the chart review. Secondary outcomes included complications diagnosed during or after the second wound review and healing time, which was defined as the duration from laceration repair to suture removal without wound dehiscence.

Additional elements extracted by the chart review included basic patient information; injury mechanism; wound examination, such as injury site, wound depth, or contamination; presence of facial bone fracture; wound closure methods; duration from injury to closure; antibiotic prophylaxis; and duration from closure to initial wound review. Wound closure methods for the epidermis and dermis were investigated separately.

Data Analysis

Patient data were divided between nonparticipant and participant groups. The nonparticipant group consisted of patients whose facial lacerations were repaired by emergency physicians who had not completed the 1-year wound closure training, while the participant group consisted of those whose facial wounds were repaired by emergency physicians who had completed the wound closure training. Since every physician had completed at least 1 year of training by March 2014, patients who arrived at our ED after April 2014 were allocated to the participant group.

Because many cofounders can cause wound dehiscence, such as wound depth, wound closure method, or comorbidity, propensity score matching was performed to compare the primary outcome, incidence of early complications after facial laceration repair, and between both groups as well as to assess secondary

outcomes. A propensity score was developed using logistic regression to estimate the probability of being assigned to the participant group compared with the nonparticipant group. Relevant covariates were identified from known risk factors for wound complications^{1,2,6,9,17–19} and precision of discrimination and propensity score calibration were analyzed using the c-statistic and Hosmer-Lemeshow goodness-of-fit test. Matching was not performed using provider status because all the wounds were repaired by a pair of physicians (an intern with a board-certified emergency physician or a resident with a board-certified emergency physician) and board-certified emergency physicians were always involved in wound closure, as well as because unmeasurable differences in suturing skills among each provider status would potentially exist.

Sensitivity analysis was conducted to validate the primary results. To confirm that the results were not dependent on the method of matching, multivariate logistic regression analysis was performed for the incidence of early complications.

Descriptive statistics are presented as means $\pm$ standard deviation (SD) or number (%). The results were compared using unpaired t-test, Mann-Whitney U-test, chi-square test, or Fisher's exact test, as appropriate. For hypothesis testing, a two-sided alpha threshold of 0.05 was considered statistically significant. All statistical analyses were conducted using SPSS and Microsoft Excel.

RESULTS

After the screening process, a total of 716 patients who presented to our ED with isolated facial injuries during the study period were identified. Among them, 654 patients had their facial lacerations closed by emergency physicians, while 32 were referred to a plastic surgeon as requested at the ED. Medical charts for wound review during follow-up visits could not be obtained in 490 patients because of unavailable consent. Although 132 patients satisfied all the inclusion criteria, 11 were excluded from the study due to delayed initial wound review (wounds were not reviewed within 3 days; the distribution of follow-up cases is shown in Data Supplement S1, Fig. S1, available as supporting information in the online version of this paper, which is available at <http://onlinelibrary.wiley.com/doi/10.1002/aet2.10115/full>). No patient suffered facial injury twice during the study period. The patient flow diagram is summarized in Figure 1.

Figure 1. Study flow diagram. We identified 716 patients who sustained isolated facial injuries, among whom 121 were included in the analyses and 80 (40 pairs) were identified in the propensity score matching.

A total of 121 patients were eligible for this study, among whom 70 (57.9%) had their facial lacerations repaired by emergency physicians who had completed the 1-year wound closure training (participant group) and 51 (42.1%) were repaired by emergency physicians who had not completed the 1-year wound closure training (nonparticipant group; Table 3). The incidence of early complications was significantly lower in the participant group than in the nonparticipant group (6 [8.6%] vs. 11 [21.6%], odds ratio [OR] = 0.34, 95% confidence interval [CI] = 0.12–0.99, $p = 0.04$; Table 4). The additional suturing or partial resuturing

was performed in such cases due to wound dehiscence originating from inadequate or incorrect wound approximation. No total revision of suturing was performed.

Patients in the participant group were younger and had more forehead lacerations than those in the non-participant group (25 ± 19 years old vs. 34 ± 21 years old and 37 [52.9%] vs. 15 [29.4%], respectively; Table 3). Although other covariates were statistically comparable between the two groups, there was non-negligible biased distribution in some known risk factors of wound dehiscence, such as comorbidities,

Table 3
Characteristics of Patients With Facial Lacerations

	Nonparticipant	Participant	- value
Case	51	70	
Age (years)	34 ± 21	25 ± 19	0.03
Sex (male)	22 (43)	31 (44)	0.9
Comorbidities			
Diabetes	2 (3.9)	1 (1.4)	0.57
Other comorbidities*	4 (7.8)	3 (4.3)	0.45
Medication†	2 (3.9)	0 (0.0)	0.18
Mechanism (blunt)	51 (100)	69 (99)	0.39
Wound depth (1–4 scale)	2.2 ± 0.7	2.3 ± 0.7	0.24
1: Dermis	5 (9.8)	5 (7.1)	
2: Subcutaneous	33 (64.7)	40 (57.1)	
3: Muscle	11 (21.6)	22 (31.4)	
4: Bone	2 (3.9)	3 (4.3)	
Facial fracture	6 (11.8)	11 (15.7)	0.54
Injury site			
Forehead	15 (29.4)	37 (52.9)	0.01
Face	19 (37.3)	19 (27.1)	0.24
Nose	5 (9.8)	4 (5.7)	0.49
Lip	8 (15.7)	5 (7.1)	0.13
Ear	2 (3.9)	2 (2.9)	1
Eyelid	2 (3.9)	3 (4.3)	1
Time from injury to closure (hours)	2.3 ± 1.1	2.4 ± 1.0	0.59
Suture			
Epidermal	42 (82.4)	51 (72.9)	0.22
Dermal	24 (47.1)	36 (51.4)	0.64
Antibiotics	25 (49.0)	43 (61.4)	0.17
Reference period (days) ‡	1.0 ± 0.7	1.1 ± 0.7	0.51

Data are reported as mean ± SD or *n* (%).

*Other comorbidities include hypertension, dyslipidemia, chronic kidney disease, brain tumor, or inflammatory bowel disease.

†Medication includes corticosteroids or immunosuppressive agents.

‡Reference period is defined as the time from closure to initial wound review.

medications, wound depth, and wound closure method (standardized mean differences [SMDs] are shown in Data Supplement S1, Table S1). To assess

whether the results were affected by these cofounders, propensity score matching was performed. The propensity model predicting the allocation to the participant group included age, comorbidities, medication that would affect wound healing, wound depth, injury site, presence of facial bone fracture, time from injury to closure, wound closure methods (epidermal suture and/or buried dermal suture), antibiotic prophylaxis, and time from closure to initial wound review. This model was validated to have high decimation and calibration for the probability of being assigned to the participant group (*c*-statistic = 0.787 and Hosmer-Lemeshow goodness-of-fit *p* = 0.76).

Among the 70 patients in the participant group, 40 patients matched with those in the non-participant group (SMDs after matching were shown in Table S1, Data Supplement S1). Propensity score matching analysis revealed that the incidence of early complications after facial laceration repair was significantly lower among physicians who completed the wound closure training than among those who had not finished the training (2 [5.0%] vs. 8 [20.0%], OR = 0.21, 95% CI = 0.07–0.61, *p* = 0.04; Table 4).

Multivariate logistic regression, which was performed as a sensitivity analysis, confirmed that the completion of the 1-year training was significantly associated with a lower incidence of early complications after facial laceration repairs (OR = 0.15, 95% CI = 0.03–0.75, *p* = 0.02, Data Supplement S1, Table S2).

The healing time did not significantly differ between the participant and nonparticipant groups (7.0 ± 2.0 days vs. 7.3 ± 2.2 days, *p* = 0.23; Table 4). Similar results were also observed after propensity score matching (7.0 ± 2.0 days vs. 7.3 ± 1.8 days, *p* = 0.22, data not shown). While only one patient in both the participant and the nonparticipant groups was diagnosed with wound infection (1 [1.4%] vs. 1

Table 4
Impact of One-year Training on Complications of Facial Laceration Repair

	Nonparticipant	Participant	OR	95% CI	p-value
Incidence of wound dehiscence					
Unadjusted analysis	11 (21.6)	6 (8.6)	0.34	0.12–0.99	0.04
Propensity score matching	8 (20.0)	2 (5.0)	0.21	0.07–0.61	0.04
Healing time* (days)	7.3 ± 2.2	7.0 ± 2.0			0.23†
Wound infection	1 (2.0)	1 (1.4)	1.38	0.08–22.60	0.80†

Data are reported as *n* (%) or mean ± SD.

*Healing time was defined as the duration from laceration repair to suture removal.

†Unadjusted analyses were performed.

[2.0%]; Table 4), no other complications, including wound dehiscence was identified during or after the second wound review.

DISCUSSION

The majority of patients with facial lacerations have been projected to be treated within EDs, and adequate treatment should be offered for the prevention of complications that could eventually cause long-term cosmetic and psychological problems.^{1,3,20,21} Although several studies have reported that facial trauma nonspecialists are capable of effectively managing facial lacerations,^{3,8,22} there are potential concerns regarding quality assurance of facial laceration repair by nonspecialists.^{3,8,11}

Given the controversy over the type and frequency of wound closure training for nonspecialists, some studies have challenged the establishment of an adequate training model for nonspecialists. An emergency residency boot camp curriculum, including 45-minute suture training has been developed and has been evaluated with a posttraining confidence level measured by questionnaire.²³ Another preparatory training opportunity for new trainees beginning their surgical residency includes a 3-hour suturing training program and was examined using knowledge tests.²⁴ Although these curricula identified a favorable effect, they were evaluated using subjective or relatively irrelevant methods and were not focused on clinical outcomes. Since we measured the number of wound dehiscence that needed additional suturing or resuturing, which is an objective clinical outcome of the current study, our training model should be practical and have a potent impact on daily practice.

Furthermore, most of the training models were developed for junior-level physicians only.^{23,24} Since patient management is typically supervised by attending physicians and provided by a team, quality of care might be enhanced by both the acquisition of technical skills by junior-level physicians and the establishment of teaching abilities by senior-level physicians. In this study, we developed an educational goal for each provider status based on their prior experience and applied the training to physicians at all levels. Since our study revealed improved outcome after we implemented this training in the ED with various levels of physicians with different backgrounds, we believe that this model might be applicable across other EDs after adjusting some of the educational goals of each provider status.

The incidence of early complications was significantly lower among the wounds repaired by physicians who had completed the training, and this result remained consistent even after propensity score matching, which is the most reliable method for reducing the effects of confounding factors (5.0% in the participant group vs. 20.0% in the nonparticipant group; OR = 0.21). Although we did not examine the early complication rate of wound repairs performed by facial trauma specialists, a recent study reported that 2.2% of facial lacerations repaired by plastic surgeons required resuturing,¹ which is close to the complication rate after the training in the current study. Our results suggest that emergency physicians could acquire optimal skills in facial laceration repair using our 1-year training model.

To the best of our knowledge, this study has been the first to utilize a reliable objective outcome and robust statistical methods in investigating the impact of a wound closure training model on favorable outcomes after facial laceration repair performed by emergency physicians. Overall, our results suggest that our 1-year wound closure training program provides nonspecialists with sufficient proficiency in performing facial laceration repair.

LIMITATIONS

The results of this study must be interpreted in the context of the study design. Wound dehiscence that needed additional suturing or resuturing was chosen as a surrogate marker for unfavorable outcomes. This may have overestimated the efficiency of the 1-year training, since we did not examine other complications such as wound infection, tissue necrosis, or facial scarring resulting in an undesired cosmetic appearance. However, given the retrospective observational nature of this study and that subjective outcome measures could carry significant bias, additional suturing or resuturing was selected as a reliable objective event. In addition, we emphasize that only two wound infections were identified throughout this study, while healing time was around 7 days, which is close to that reported in previous studies (5–10 days).^{1,25,26}

Another limitation of our study concerns the fact that patient data matching was not performed using provider status (intern, resident, or board-certified emergency physician) or with physicians who acquired more skills following the mandated training curriculum. The results might have been modified if the

distribution of provider status or additional training experience had been unbalanced between the participant and nonparticipant groups. However, matching with such covariates was technically difficult because the wounds were always repaired by a pair of physicians (an intern with a board-certified emergency physician or a resident with a board-certified emergency physician) and board-certified emergency physicians were always involved in wound closure, as well as because only six (5.3%) of the emergency physicians who completed the 1-year training repeated portions of the training. Although limited in scope, considering the unchanged distribution of each provider status throughout the study period and only slight extracurricular training, our results would still provide a practical framework for developing a training model. It should also be noted that no significant difference in wound closure outcome between provider statuses among facial trauma nonspecialists was reported.²⁷

Furthermore, because the 1-year training was initiated as a quality improvement project, the maturation effect in each emergency physician should be considered. Although this bias may have overestimated our results, the study period was limited to within 15 months after the initiation of training to minimize the maturation effect. We believe this bias would only slightly affect the results given that the curricula for our residency program or intern schedule, other than the wound closure training, remained after the training implementation and the maturation period was no longer than 15 months.

Finally, this study was conducted at a single institution, which may limit the generalizability of our findings, as there should be the high regional variation between EDs regarding facial wound closure practice. However, the training curriculum and the educational goal of each provider status in the current study were developed based on their prior experience, which might be easily modified at other EDs. Considering the improved outcome following the implementation of our 1-year training, we believe this model might be practical and applicable across other EDs after adjusting some of the training contents presented herein.

CONCLUSIONS

The incidence of early complications after facial laceration repair was significantly lower among wounds repaired by physicians who had completed 1 year of

training. Future wound closure training models and curricula for nonspecialists in facial trauma should consider the 1-year curriculum presented herein, which could improve the outcome of facial laceration repair.

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Supporting Information

The following supporting information is available in the online version of this paper available at <http://onlinelibrary.wiley.com/doi/10.1002/aet2.10115/full>
Data Supplement S1. Supplementary appendix.