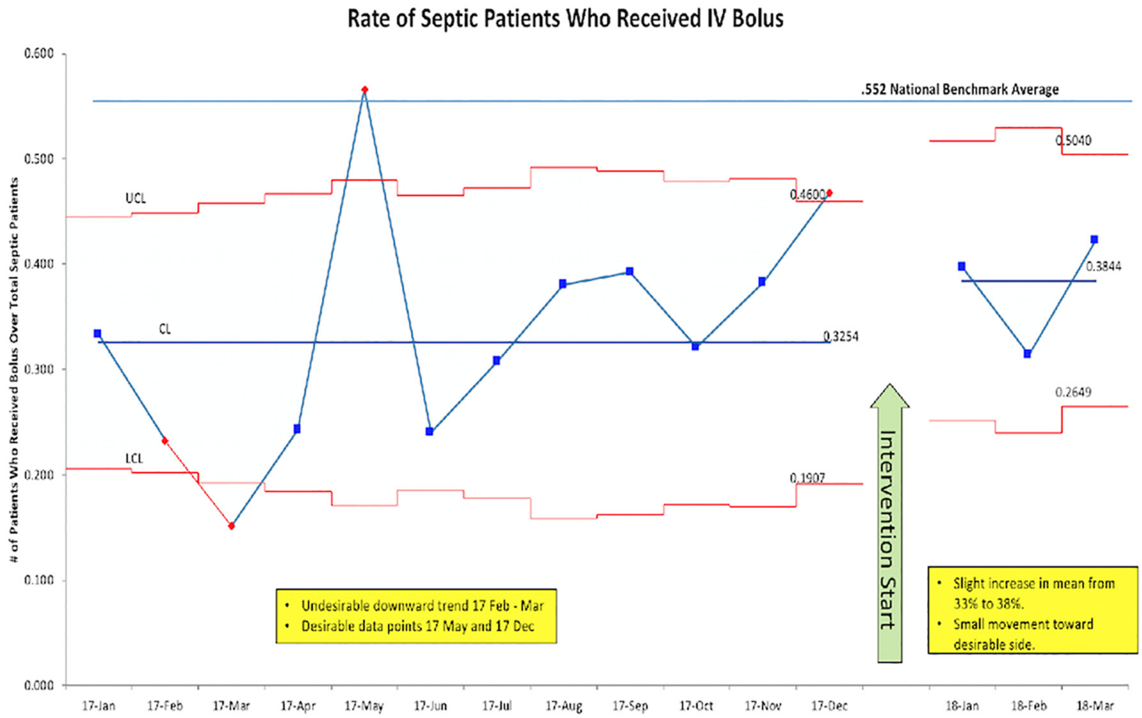

Fig. 1.

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References

[1] Reducing Sepsis Mortality. Joint Commission Center for Transforming Healthcare; 2017http://www.centerfortransforminghealthcare.org/projects/detail.aspx?Project=8, Accessed date: 10 March 2018 [Published].
[2] Tefera L, Slesinger T. Sepsis Wave II CMS SEP-1 Measure—Early Insights and Experience. American College of Emergency Physicians; 2017https://www.acep.org/globalassets/uploads/uploaded-files/acep/advocacy/federal-issues/equal/sepsis-march-webinar.pdf, Accessed date: 10 March 2018.
[3] Sepsis Alliance Responds to Study Revealing Sepsis as Number One Cause of Hospital Readmissions. Sepsis Alliance. http://www.sepsis.org/news/2016/number_one_cause_of_readmissions/; January 25, 2016, Accessed date: 5 March 2018. [Published].
[4] Sonoo T, Nakamura K, Ando T, et al. Prospective analysis of cardiac collapsibility of inferior vena cava using ultrasonography. J Crit Care 2015;30:945–8 [Accessed March 8, 2018].
[5] Inferior vena cava ultrasound for volume status. Family Practice Notebook; August 6, 2017http://www.fpnotebook.com/CV/Rad/InfrVnCvUltrsndFrVlmSts.htm, Accessed date: 12 March 2018. [Published].
[6] De Lorenzo RA, Holbrook-Emmons VL. Ultrasound measurement of inferior vena cava diameters by emergency department nurses. Adv Emerg Nurs J 2014;36:271–8 [Accessed March 11, 2018].
[7] Santistevan J. Sepsis CMS Core Measure (SEP-1) Highlights. American College of Emergency Physicians; 2016https://www.acep.org/how-we-serve/sections/quality-improvement–patient-safety/newsletters/march-2016/sepsis-cms-core-measure-sep-1-highlights/#sm.000f0q0q05xff9x10vt1azn6p774n, Accessed date: 10 March 2018 [Published].
[8] Ibarra AB. California's RN Wages Now Highest in the Nation, Federal Data Show. Kaiser Health News; October 24, 2016https://khn.org/news/californias-rn-wages-now-highest-in-the-nation-federal-data-show/, Accessed date: 15 March 2018 [Published].
[9] Echo tech salaries in California. Indeed. https://www.indeed.com/salaries/Echo-Tech-Salaries,-California; 2017, Accessed date: 11 March 2018. [Published, Updated July 19, 2018].
[10] San Diego, CA: Heart EKG (Transthoracic - Echocardiogram) Cost Comparison. New Choice Health, Inc.; 2018https://www.newchoicehealth.com/places/california/san-diego/echo/heart-ekg-transthoracic-echocardiogram, Accessed date: 13 March 2018 [Published].
[11] SSC hour-1 bundle. Society of Critical Care Medicinehttp://www.survivingsepsis.org/Bundles/Pages/default.aspx, Accessed date: 15 March 2018.

A leadership-based program can reduce boarding time of emergency department admissions

To the Editor

Emergency medicine leadership may have a role in not only helping to identify successful solutions to crowding in the emergency departments (EDs), but also becoming a communication bridge between frontline workers and personnel out of the ED [1,2]. We conducted a leadership-based quality improvement (QI) program to improve boarding time of ED admissions in the Hsin-Chu branch of the National Taiwan University Hospital (NTUH) between January 2014 and December 2016. The ED director acted as the team leader, and the ED frontline workers, and the administrative personnel as members.

The Hsin-Chu branch is a regional academic hospital with 600 acute-care beds. The ED is staffed by 5 attending physicians at day-shift and 4 at night-shift, all with board certified in emergency medicine, and has approximately 76,000 visits per year. The decision for admission is made by the emergency physicians and specialists simultaneously. The process of ED admissions is shown (Fig. 1).

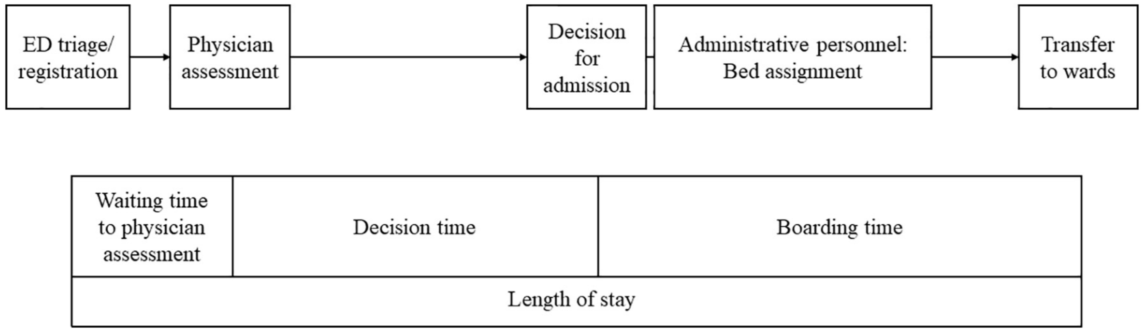

Fig. 1. The admission flow diagram.

The data in 2014 showed the ED admissions exhibited longer length of stay (LOS) (median, 388 min; interquartile range, IQR, 154–1021 min), comparing with non-admissions (median, 65 min, IQR, 26–162 min). The median decision time and boarding time were 162 (IQR, 66–392) and 205 (IQR, 83–600) min, respectively. Over 70% of the admissions were transferred to the ward after 10 a.m. After team discussion, reducing boarding time was chosen as the QI task.

The QI interventions through brain-storming process begun since 2015. The ED director organized education sessions for the QI team. The nurse practitioners reported the in-scene complicated cases and the ED director would give an instruction for managing these cases. The nurse practitioners reported the current number of patients waiting for admission, and the nurse leaders reported the current number of patients staying in the ED to the ED director. The ED director summarized the admission bed requests and the administrative personnel reported the current bed vacancy via real-time group discussion using mobile messaging. The ED director also initiated a collaborative on-line meeting twice a day for monitoring the process. Additionally, the ED director reported the monthly QI outcomes to the ED workers and in the hospital affairs meeting. Moreover, the ED patients could be admitted before 8 a.m. if the beds were vacant (early admission).

The primary outcome measures were boarding time for the ED admissions. Secondary outcomes included decision time, LOS, and the percentage of LOS over 24 h for ED admissions and all patients. The SAS software (SAS 9.4, Cary, North Carolina, USA) was employed. Student's t-test was performed for the continuous data, as well as Chi-square test for the categorical data. We adopted a joinpoint trend analysis to evaluate the efficacy and sustainability. A p-value of <0.05 was considered statistically significant.

Tables 1 and 2 show the characteristics of ED visits and admissions during the study period. In 2016, pandemic influenza season and shortage of beds due to shock-proof repair had impacted the ED flow and the admission rates.

There was significant and sustainable reduction in boarding time for ED admissions (Table 2). Fig. 2 depicted monthly variation in the decision time, boarding time and LOS. In the trend analysis, the results also showed a significant and sustainable reduction (2014 *v.s.* 2015, $p < 0.0001$; 2015 *v.s.* 2016, $p = 0.0077$).

A significant decrease was also found in the percentage of LOS over 24 h for ED admissions and all patients (Tables 1, 2). The decrease for the percentage of LOS over 24 h was significant (2014 *v.s.* 2015, $p < 0.0001$; 2015 *v.s.* 2016, $p = 0.38$) in all patients (Fig. 3), as well as the ED admissions (2014 *v.s.* 2015, $p = 0.011$; 2015 *v.s.* 2016, $p = 0.68$) (Fig. 4).

Prolonged boarding time can reduce the capacity of ED to evaluate new patients, in turn leading to ED crowding [3]. This study well demonstrates a successful leadership-based QI program in a regional academic hospital. After the implementation, the boarding time for ED admissions can be reduced by 50%. In addition, there were approximately 45% and 27% reductions in the percentage of LOS over 24 h for all patients and admissions, respectively.

Table 1
The demographic data of the ED visits before and after the implementation.

Characteristics	Pre-intervention (2014)	Implementation (2015)	Sustainability (2016)
Total ED visits, n*	76116	76,845	80,650
Ambulance, n (%)	4355 (5.7)	4673 (6.1)	5042 (6.3)
Triage level 1–3, n (%)	59795 (78.6)	65,821 (85.7)§	69,074 (85.6)
Mortality, n (%)	112 (0.1)	113 (0.1)	120 (0.1)
Transfer, n (%)	512 (0.7)	451 (0.6)	649 (0.8)
Discharge against medical advice, n (%)	970 (1.3)	877 (1.1)	845 (1.0)
Admission, n (%)	13761 (18.1)	13,326 (17.3)	12,633 (15.7)**
ED admission rate for hospital admission, %†	56.4 ± 2.4	51.4 ± 2.2***	47.5 ± 3.1
Hospital bed occupancy rate, %†	73.6 ± 2.0	75.2 ± 3.4	76.0 ± 3.2
Length of stay, min‡	89 (31–240)	97 (34–243)	98 (35–245)
Percentage of length of stay over 24 h, %†	3.27 ± 0.01	1.81 ± 0.01§	1.82 ± 0.01

* Excluded patients left without seen.
† Presented as mean ± standard deviation (SD).
‡ Presented as median (interquartile range, IQR).
§ $p < 0.0001$ when comparing with data between 2014 and 2015.
** $p < 0.001$ when comparing with data between 2015 and 2016.
*** $p < 0.05$ when comparing with data between 2014 and 2015.

Table 2
The characteristics of the ED admission visits before and after the implementation

Characteristics	Pre-intervention (2014)	Implementation (2015)	Sustainability (2016)
ED admission, n	13761	13,416	12,644
Age, years*	54.5 ± 32.9	54.8 ± 32.2	54.2 ± 33.0
Male gender, n (%)	7772 (56.4)	7584 (56.5)	7121 (56.3)
Ambulance, n (%)	1860 (13.5)	1969 (14.6)	1606 (12.7)
Triage level 1–3, n (%)	12876 (93.6)	12,871 (95.9)‡	12,079 (95.5)
Weekend/holiday, n (%)	3941 (28.6)	3949 (29.4)	3641 (28.8)
Consultations, n (%)	3032 (22.0)	2932 (21.8)	2941 (23.2)
Admission before 8 a.m., n (%)	–	862 (6.4)	473 (3.7)§
Length of stay, min†	388 (154–1021)	370 (169–921)	379 (170–962)
Medical decision time, min†	162 (66–392)	158 (70–388)	165 (69–398)
Boarding time, min†	205 (83–600)	100 (41–302)**	91 (36–272)**
Percentage of length of stay over 24 h, %*	2.2 ± 1.5	1.6 ± 1.3**	1.8 ± 1.3

* Presented as mean ± SD.
† Presented as median (IQR).
‡ $p < 0.001$ when comparing with data between 2014 and 2015.
§ $p < 0.01$ when comparing with data between 2015 and 2016.
** $p < 0.0001$ when comparing with data between two consecutive years.

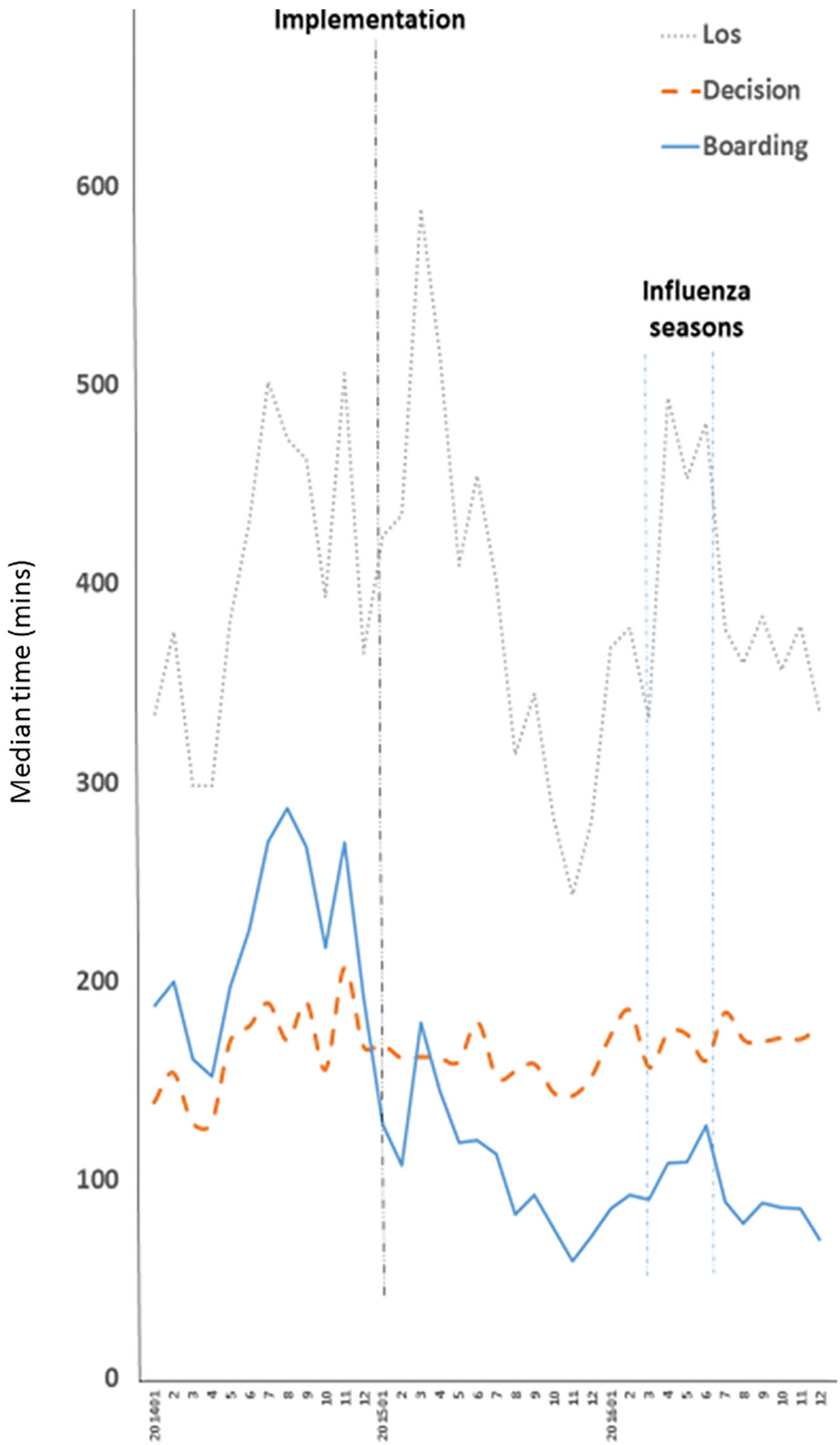

Fig. 2. The monthly variation in median LOS (dotted line), decision time (dashed line) and boarding time (solid line) for ED admissions before and after the implementation.

Strong leadership with management skills, and driving change through an extensive process is the critical factor behind the successful implementation [4,5]. In this study, the ED director did the great efforts through multi-level engagement, from the frontline workers to the hospital level, making the marked improvement for ED admission process.

Although there was a significant improvement in inpatient boarding, the LOS and decision time were not apparently changed. However, the percentage of patients with LOS over 24 h was reduced significantly. It implies that the interventions can reduce extremely prolonged LOS. In addition, the decision time was significant shorter, comparing with those in other studies [6,7]. The routine examinations such as laboratory results and imaging studies, may take a certain amount of time. Therefore, it may explain that the difference is not apparently in decision time.

Although LOS varied greatly by disposition [8], the percentage of the all patients staying over 24 h was significantly decreased. It implies the positive benefits would extend to the non-admitted patients with extreme LOS.

Despite of these contributions, there were some limitations. First, the successful results were gathered from a single institution. The major causes for ED crowding would vary from hospital to hospital. However, this study

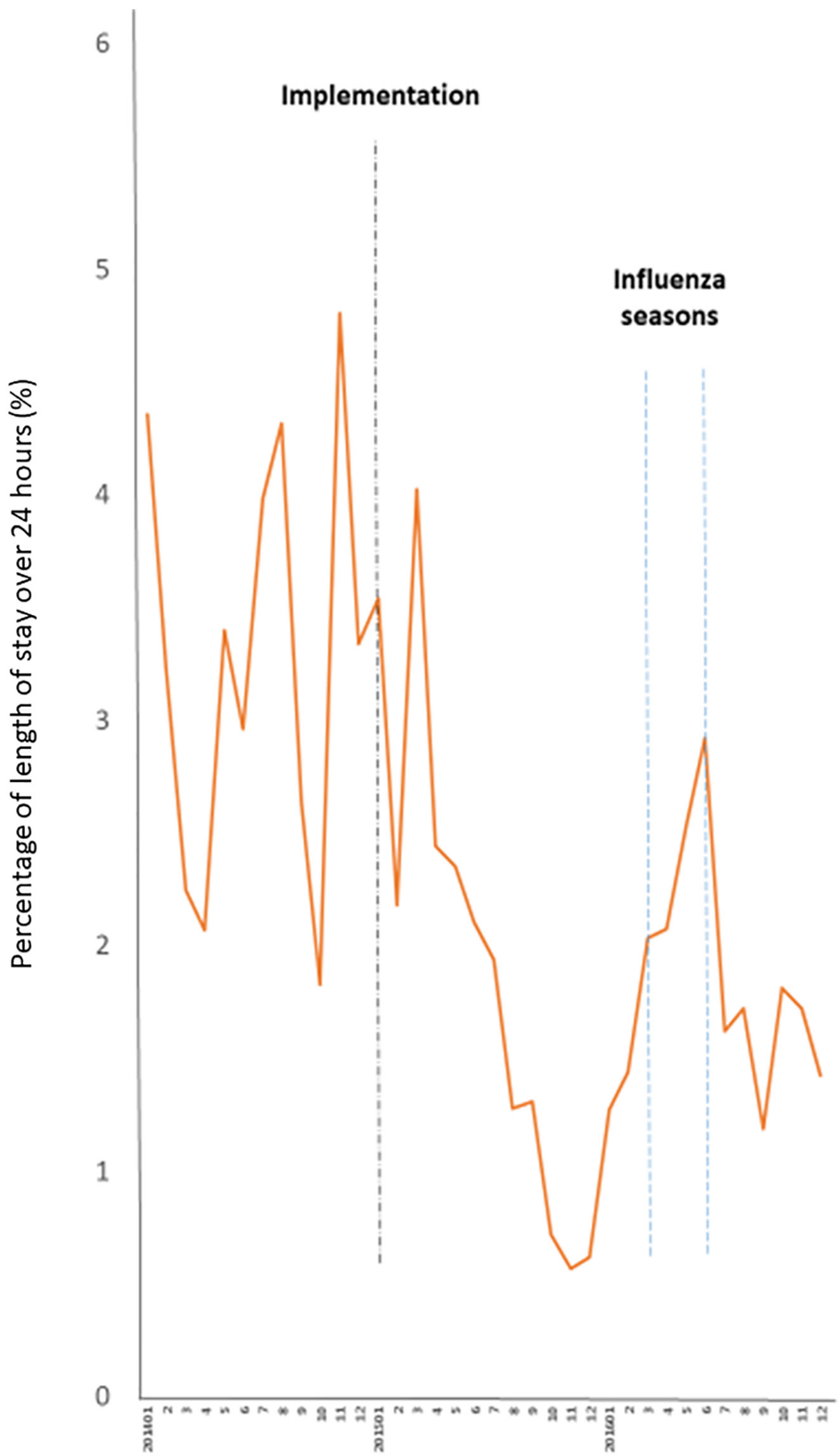

Fig. 3. The percentage of all ED patients staying over 24 h on a month-by-month basis before and after the implementation.

presents how we think rather than a solving prescription. The structured QI process can reproduce and be tailored for any health care system. Second, one may wonder the ED is not crowded because of medium volume of ED visits. However, the ED space is limited to be easily stuffed by the patients and the ED workers. The QI program truly creates the coherence and improves ED efficiency. Moreover, the surrogate outcome such as patient or staff satisfaction after the implementation did not included. Further studies will be needed for these markers.

In conclusion, the leadership-based QI program is a successful example to reduce boarding time of ED admissions. Whether the improvements translated into improvements in patient or staff satisfaction outcomes would be determined in the further investigations.

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Conflicts of interest

No potential conflicts of interest for each author.

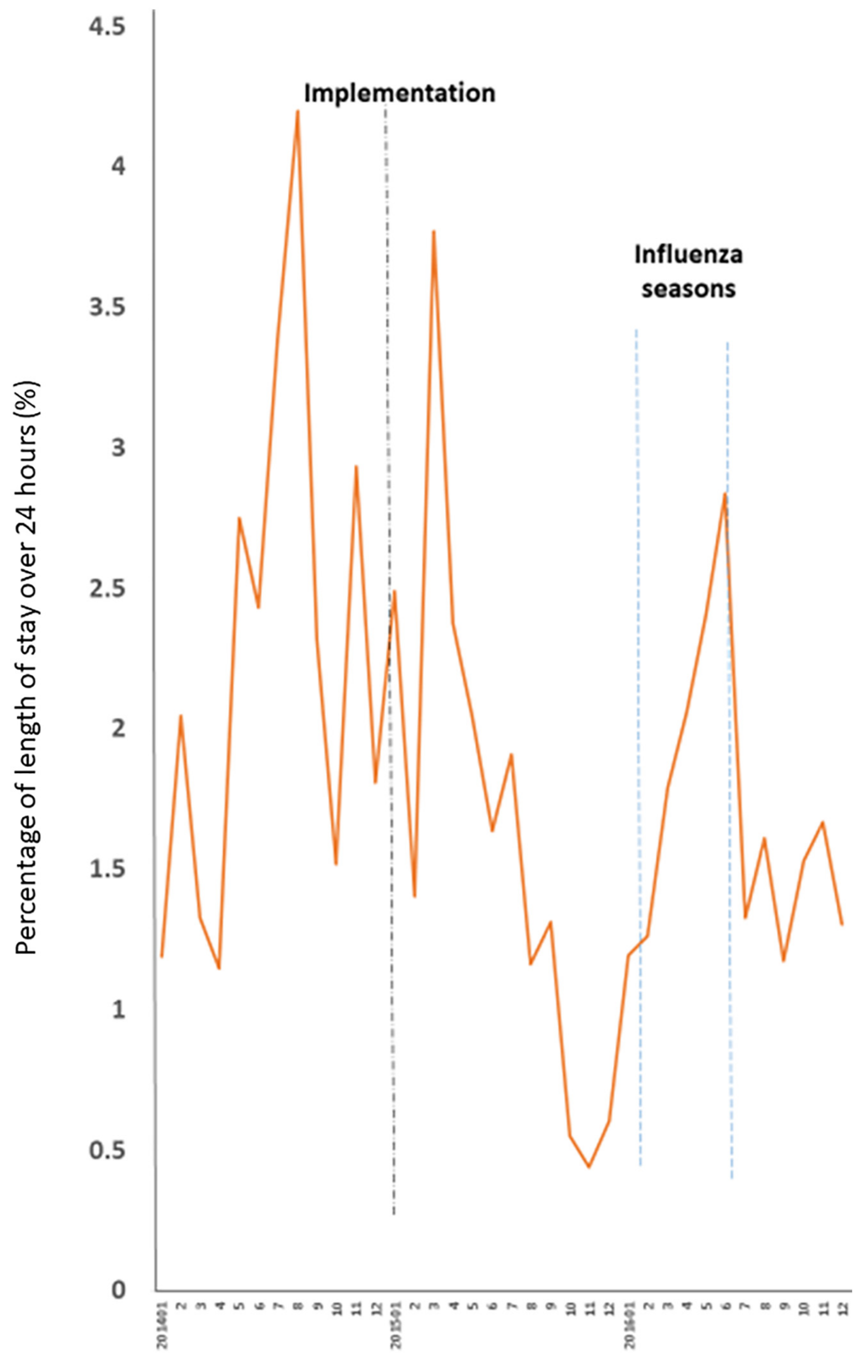

Fig. 4. The percentage of ED admissions staying for over 24 h on a month-by-month basis before and after the implementation.

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References

[1] Crowding ACEP. Policy statement. Ann Emerg Med 2013;61:726–7. https://doi.org/10.1016/j.annemergmed.2013.03.037.

[2] Green SA, Bell D, Mays N. Identification of factors that support successful implementation of care bundles in the acute medical setting: a qualitative study. BMC Health Serv Res 2017;17:120. https://doi.org/10.1186/s12913-017-2070-1.

[3] Chang AM, Cohen DJ, Lin A, Augustine J, Handel DA, Howell E, et al. Hospital strategies for reducing emergency department crowding: a mixed-methods study. Ann Emerg Med 2018;71:497–505. https://doi.org/10.1016/j.annemergmed.2017.07.022.

[4] Goodridge D, Westhorp G, Rotter T, Dobson R, Bath B. Lean and leadership practices: development of an initial realist program theory. BMC Health Serv Res 2015;15:362. https://doi.org/10.1186/s12913-015-1030-x.

[5] McClelland MS, Lazar D, Sears V, Wilson M, Siegel B, Pines JM. The past, present, and future of urgent matters: lessons learned from a decade of emergency department flow improvement. Acad Emerg Med 2011;18:1392–9. https://doi.org/10.1111/j.1553-2712.2011.01229.x.

[6] Patel PB, Combs MA, Vinson DR. Reduction of admit wait times: the effect of a leadership-based program. Acad Emerg Med 2014;21:266–73. https://doi.org/10.1111/acem.12327.

[7] Ding R, McCarthy ML, Desmond JS, Lee JS, Aronsky D, Zeger SL. Characterizing waiting room time, treatment time, and boarding time in the emergency department using quantile regression. Acad Emerg Med 2010;17:813–23. https://doi.org/10.1111/j.1553-2712.2010.00812.x.

[8] Pearlmutter MD, Dwyer KH, Burke LG, Rathlev N, Maranda L, Volturo G. Analysis of emergency department length of stay for mental health patients at ten Massachusetts emergency departments. Ann Emerg Med 2017;70:193–202. https://doi.org/10.1016/j.annemergmed.2016.10. 005.

Evaluation of the tensile strength and microbial barrier properties of a novel, 2-octly-cyanoacrylate based topical skin adhesive

Topical skin adhesives (TSA) are non-invasive alternatives to suturing or stapling [1]. Cyanoacrylate-based TSA were introduced into clinical use in the late 1950s. Since then, a number of commercial butyl-based, octyl-based, and blended cyanoacrylate adhesives have become available. It has been estimated that of roughly 10 million lacerations and 100 million surgical incisions each year in the U.S., between 1 in 10 and 1 in 3 could be closed with a TSA [2]. As a result, there has been continued development of improved and less expensive TSA.

In addition to closing approximated wounds, the cyanoacrylate-based TSA also have been shown to have microbial barrier properties [3-5] as well as direct antimicrobial activity [6,7]. Thus, TSA have the potential to reduce wound infections commonly seen after wound repair. The current study was designed to compare the mechanical characteristics of Dermabond (the most commonly used TSA) and a novel 2-octyl-cyanoacrylate compounded using proprietary elasticizers and thickeners to provide unique performance characteristics of strength, flexibility and skin bonding adherence (Actabond) in an ex-vivo porcine skin strip model. We also assessed the in-vitro microbial barrier properties of Actabond.

Skin strips (10 mm × 50 mm) harvested from the back/shoulder region of domestic pigs were used to measure tensile strength ex-vivo. The strips were thawed on a hot plate set at 35 °C and the underlying fat layer was removed. The strips were cut in half widthwise and approximated with no gaps in between. The TSA (Dermabond or Actabond) were randomly applied in a single layer over the surface of the approximated strips and allowed to cure for 5 min on the hot plate. The ends of the strips were then placed within the grips of a tensiometer that measured the maximal force required to separate the wound edges. The grips were separated at a speed of 20 in./min. 20 approximated skin strips were tested for each TSA by an investigator masked to treatment allocation.

In order to test its microbial barrier function, we applied Actabond adhesive directly onto agar plates to form a polymer film. These films were then inoculated with test solutions containing an infectious inoculum of five commonly encountered pathogens causing wound infections (Methicillin-resistant *S. aureus*, Methicillin-resistant *S. epidermidus*, *P. aeruginosa*, *E. coli*, and *E. faecium*). The microbial barrier was considered appropriate when there was no growth observed beneath the polymer film.

The mean [95% CI] tensile strength of Actabond (20.2 N [14.1–26.3]) was significantly greater than the tensile strength of Dermabond (12.5 N [8.2–16.7]); mean difference 7.7 N (95% CI, 0.6–14.8). The percentage elongation of the adhesive prior to breakage, and mode of failure (either cohesive or adhesive) was similar in skin strips approximated with Actabond or Dermabond. For all five organisms tested, no microbial growth of the challenge organism was observed for the 30 test articles after incubation for 72 h, indicating that the Actabond maintained its microbial barrier properties.

Our results demonstrate that the tensile strength of a novel topical skin adhesive, Actabond, is significantly higher than that of Dermabond. While it is likely that an adhesive with greater tensile strength would lead to a lower wound dehiscence rate in patients with repaired incisions or lacerations than one with lower tensile strength, only a randomized clinical trial would be definitive.

No studies have actually measured the mechanical forces required to separate the edges of repaired lacerations and incisions both immediately after wound closure and at later time-points. A study in human volunteers has tried to estimate the pressures within the abdominal cavity (and presumably the forces applied to the abdominal wall) during various activities. For example, an intra-abdominal pressure of approximately 130 mm Hg was measured during the act of coughing [8]. Thus, an adhesive with a tensile strength of greater than 130 mm Hg or 17 N (such as Actabond) would be unlikely to fail when subject to the forces generated by coughing.

Our study results also demonstrate that Actabond is very effective as a microbial barrier as evidenced by the 100% effectivity in preventing growth of the inoculated organisms beneath the polymer film. Prior studies have shown that other butyl- and octyl-based cyanoacrylate TSA are also very effective as microbial barriers [3-5]. Several animal studies have also shown that contaminated wounds repaired with a cyanoacrylate-based TSA have lower wound infection rates than similar wounds closed with sutures [6,7].

Our study has several notable limitations. The study was conducted ex-vivo on porcine skin strips and may not predict wound failure on actual patients. Furthermore, the clinical relevance of a 7.7 N difference in tensile strength remains unclear. In addition, tensile strength was only measured once, almost immediately after approximating the skin strips.

We conclude that Actabond is stronger than Dermabond when tested with approximated porcine skin strips. Actabond is also an effective microbial barrier to commonly encountered wound pathogens causing wound infection.

Conflicts of interest

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