EDUCATION

Simulation Training in Penile Implant Surgery: Assessment of Surgical Confidence and Knowledge With Cadaveric Laboratory Training

Aaron C. Lentz, MD,[1] Dayron Rodríguez, MD, MPH,[2] Leah G. Davis, MS,[1] Michel Apoj, BS,[2] B. Price Kerfoot, MD,[3] Paul Perito, MD,[4] Gerard Henry, MD,[5] LeRoy Jones, MD,[6] Rafael Carrion, MD,[7] John J. Mulcahy, MD, PhD,[8] and Ricardo Munarriz, MD[2]

ABSTRACT

Introduction: Constraints on surgical resident training (work-hour mandates, shorter training programs, etc.) and availability of expert surgical educators may limit the acquisition of prosthetic surgical skills. As a result, training courses are being conducted to augment the prosthetic surgery learning experience.

Aim: To evaluate the impact of a hands-on cadaver-based teaching program on resident procedural knowledge and procedural confidence with placement of a penile prosthesis.

Main Outcome Measure: Changes in procedural knowledge and self-confidence following a focused training program on penile prosthetics.

Methods: As part of the 2017 Society of Urologic Prosthetic Surgeons and the Sexual Medicine Society of North America Annual Meeting, 31 urology residents participated in a simulation lab in prosthetic urology. The lab included didactic lectures and a hands-on cadaveric laboratory. Participants completed surveys before and after the course. Wilcoxon Signed Rank tests for matched pairs were used to compare respondents' pre- and postcourse knowledge (% questions answered correctly) and confidence ratings. Prior implant experience was assessed.

Results: 31 residents participated in this study. The majority of the participants were 4th- (41.9%) and 5th-year residents (38.7%). Participants showed a significant improvement in procedural knowledge test scores (68.8±13.4 vs 74.2 ± 13.0, $P < .05$) and self-reported increased median surgical confidence levels (4 vs 3, P value $< .001$) after completion of the cadaveric course. Subgroup analysis demonstrated that residents with prosthetic surgery experience of <10 cases benefited the most. In addition, improvement in surgical confidence levels observed was greater than the improvement in surgical knowledge. The overall cost of the simulation training course was approximately $1,483 per resident.

Conclusion: Simulation training in prosthetic surgery seems to improve surgical confidence and knowledge. Further research is needed to better understand the benefits and limitations of simulation training. **Lentz AC, Rodríguez D, Davis LG. Simulation training in penile implant surgery: Assessment of surgical confidence and knowledge with cadaveric laboratory training. Sex Med 2018;6:332−338.**

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[1]Division of Urologic Surgery, Duke University, Raleigh, NC, USA;
[2]Department of Urology, Boston Medical Center, Boston, MA, USA;
[3]Veterans Affairs Boston Healthcare System, Boston, MA, USA;
[4]Department of Urology, Coral Gables Hospital, Coral Gables, FL, USA;
[5]ArkLaTex Urology, Bossier City, LA, USA;
[6]Urology San Antonio, San Antonio, TX, USA;
[7]Department of Urology, University of South Florida, Tampa, FL, USA;
[8]Department of Urology, University of Alabama, Madison, AL, USA

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INTRODUCTION

Technologic advances over the last 2 decades have revolutionized urologic practice. Urologic interventions have evolved from maximally invasive open surgery to minimally invasive approaches. Trainees are now expected to master open, endoscopic, microscopic, laparoscopic, and robotic surgeries in a 5-year residency period. The need to learn multiple and diverse operative techniques combined with constraints on surgical resident training (work-hour mandates, shorter training programs, educational costs, pressure to reduce operating room times) are limiting the acquisition of all penile prosthesis surgical skills.[1,2] This situation raises fundamental questions regarding the delivery and acquisition of postgraduate urologic surgical training.

Simulation surgical training has proven to be a valid and an increasingly popular method to teach surgical skills and enhance resident performance in the operating room.[3–7] Traditional educational methods (reading, surgical videos, didactive activities, etc.) in conjunction with surgical simulation training may be the most efficient and safest way to train and educate urology residents.[4,7] However, there is need for the development and validation of simulation-based training methods including bench-top synthetic models, animal models, cadaveric labs, and more recently virtual reality training platforms in teaching all aspects of urologic surgery.

This is particularly relevant in the area of prosthetic urology, which remains an important and effective treatment option for male erectile dysfunction refractory to medical therapy. Penile prosthesis implantation has evolved over the last decades and offers a durable, safe, and effective treatment option associated with high patient satisfaction.[8] Penile prosthetic surgery is expected to be learned during urologic residency; however, variable patient demographics and lack of faculty expertise leads to significant differences in terms of competency among trainees nationwide. It is estimated that approximately 15% of urology training programs in the United States have a dedicated prosthetic urologist.[9] In fact, as of 2015 the majority of penile prostheses (>75%) were placed by urologists who performed <5 implant surgeries per year.[10] Many urologists feel apprehensive and uncomfortable placing penile prostheses because of limited training during residency, low prosthetic urology surgical volume and experience, and intra- and postoperative complication management. In particular, urologists experience significant anxiety with the skill of reservoir placement during a 3-piece inflatable prosthesis placement because it has been associated with significant rates of bladder and vascular injuries. Interestingly, the Accreditation Council for Graduate Medical Education does not specify or require a minimum number of prosthetic cases.[11]

The challenge in prosthetic urology training should then focus on how to provide optimal training in prosthetic urology for trainees with limited experience. King et al[12] demonstrated that yearly sessions with a recognized expert can improve surgical outcomes, implant type, volume of implants, and can reduce explantation/revision rates. This model may improve training of urologic residents in penile prosthetics surgery, but requires a high-volume implanter to travel to a specific residency program that is very difficult and complex in logistic terms (surgery scheduling, temporary surgical privileges, etc.). In addition, given the limited number of cases that can be performed in a few days using this model, it is possible that only a handful of residents may benefit.

An alternative teaching model is the use of cadaveric training labs led by a panel of high-volume implanters to educate a larger number of trainees nationwide. This educational model allows for supplementary simulation "expert classes" in accordance with the trainee level of training, enabling them to better understand the anatomy, refine their skills, experience anatomic variations, and approach real-life challenges under expert supervision in a safe environment that will not harm patient care. In prosthetic urology, the educational effect of these simulation and skills courses has not been reported. In particular, whether relatively short simulation experiences are of educational benefit, even in the short-term, is of interest.

The aim of this study was to evaluate the impact of simulation surgical training on resident surgical knowledge and confidence with placement of a 3-piece penile prosthesis. Our secondary objective was to determine how trainee characteristics (gender, age, training, experience, etc.) affect the extent of the improvement in knowledge and confidence levels.

MATERIALS AND METHODS

This is prospective institutional review board (IRB)-approved study of 31 residents who participated in the 2017 Society of Urologic Prosthetic Surgeons (SUPS) and the Sexual Medicine Society of North America Annual Meeting (SMSNA), which took place in San Antonio, TX, USA.

SUPS sent out letters to all U.S. residency program directors 4 months before the SUPS/SMSNA meeting, encouraging them to nominate a resident from their program to attend the meeting as well as the cadaver course. Resident program directors were told that through unrestricted educational grants, SUPS was sponsoring the surgical symposium free of charge to North American urology residents. Each participant received coach airfare, 2-night hotel accommodations, meals, and meeting registration. The nominating resident criteria included: (i) 4th- or 5th-year urology resident of an American Urological Association-accredited residency program, (ii) leadership skills within their urology residency, and (iii) strong interest in improving surgical skills and knowledge in prosthetic urology. The final cohort of residents was diverse in terms of previous prosthetic experience and representative of all regions of the United States (data not shown).

All course participants completed a mandatory non-validated presimulation course questionnaire, which was sent out via REDCap (Research Electronic Data Capture, Nashville, TN, USA) 2 months before the course (Appendix A). REDCap is a secure web application for building and managing online surveys and databases. The survey evaluated the resident's prosthetic procedural knowledge and surgical confidence placing a 3-piece inflatable penile prosthesis.

The simulation course included didactic lectures and videos on the following topics:

1.) the advantages, disadvantages, and surgical technique of scrotal, subcoronal, and infrapubic penile prosthesis approaches
2.) similarities, differences, benefits, and limitations of the different types of penile prosthesis devices
3.) surgical, infectious, anatomic, and geometric considerations during revision of malfunctioning penile prosthesis
4.) management of penile prosthesis complications

After the didactic lectures, residents rotated through 9, 25-minute cadaveric stations (5 penile prosthesis placements, 3 male slings, and an artificial urinary sphincter). Immediately after the cadaver lab, participants were asked to complete a postlab survey via REDCap, which was the exact same survey that they had completed 2 months before the course.

Participants' procedural knowledge was evaluated by 15 multiple-choice questions. This questionnaire was based on questions examining the recommendations of the International Consultation on Sexual Medicine.[13] Surgical confidence was evaluated by 15 statements using a 5-point Likert scale (Not at all confident, Minimally confident, Average confidence, Above average confidence, Very confident). If a participant did not complete both surveys or did not participate in the cadaver lab, the participant was then excluded from the study.

Of the 32 residents who participated in the cadaver lab, 31 completed the questionnaires and were available for analysis.

Statistical Analysis

Cohort characteristics are presented as counts and percentage for categorical variables and median and range for continuous variables. A total score for the knowledge survey was calculated taking the sum of respondents' correct responses and dividing by the total number of questions. This score is reported as a percent and standard deviation. To simplify presentation, individual question responses were collapsed into "correct" or "incorrect" and are reported as counts of and percent of correct responses.

On Shapiro-Wilk testing no deviance from normality was detected, so parametric testing was used to test whether there was an overall difference in test score. *T*-test for matched pairs was used to compare overall scores pre- and postlectures and cadaver lab. McNemar paired binomial tests were used to compare the number of correct responses pre- and postlecture and cadaver lab for each individual question. An overall measure of confidence was obtained by assigning numbers 1 to 5 to the response choices (Not at all confident = 1, Minimally confident = 2, Average confidence = 3, Above average confidence = 4, Very confident = 5), calculating the median of respondents' values across questions This overall confidence is reported as a median and interquartile range. Individual confidence statements are reported as both a median confidence and interquartile range as well as counts and percentage of responses in each response choice.

Wilcoxon Signed Rank tests for matched pairs were used to compare respondents' pre- and postlectures and cadaver lab median confidence ratings overall and for each of the 15 statements individually. Covariates of interest included gender, participant's age, level of training (postgraduate year and implant experience). A P value of .05 was considered statistically significant. All analyses were implemented using the R statistical software, version 3.4.1 (The R Foundation, Vienna, Austria).

Table 1. Overall resident characteristics

Characteristic	Overall
N	31
Gender = Female (%)	7 (22.6)
Age (median [range])	30.00 [28.00, 35.00]
Level of Training (%)	
PGY-3	2 (6.5)
PGY-4	13 (41.9)
PGY-5	12 (38.7)
PGY-6	4 (12.9)
Implant Experience (Cases) (%)	
<10	11 (35.5)
10–20	14 (45.2)
>20	6 (19.3)

PGY = postgraduate year.

RESULTS

Table 1 summarizes the resident characteristics. 31 residents (median age: 30 years old; 24 males, 7 females) participated in this study. The majority of the participants were 4th (41.9%)- and 5th-year residents (38.7%). Precourse surgical exposure to penile prosthetic surgery consisted of <10 (35.5%), 10–20 (45.2%), and >20 cases (19.3%) during their residency.

Participants experienced a significant improvement in procedural knowledge test scores (68.8 ± 13.4 vs 74.2 ± 13.0, $P < .05$) after course completion (Figure 1A). 19 (61.2%) trainees improved their knowledge test scores, 8 participants had lower test scores, and 4 residents received the same score. Interestingly, there was a significant worsening in Question 8 (67.7% precompletion and 35.5% postcompletion, $P = .016$), which asked about how to deal with proximal corporal perforation. Trainees needed to recognize that proximal perforation with a narrow dilator does not always require formal repair.

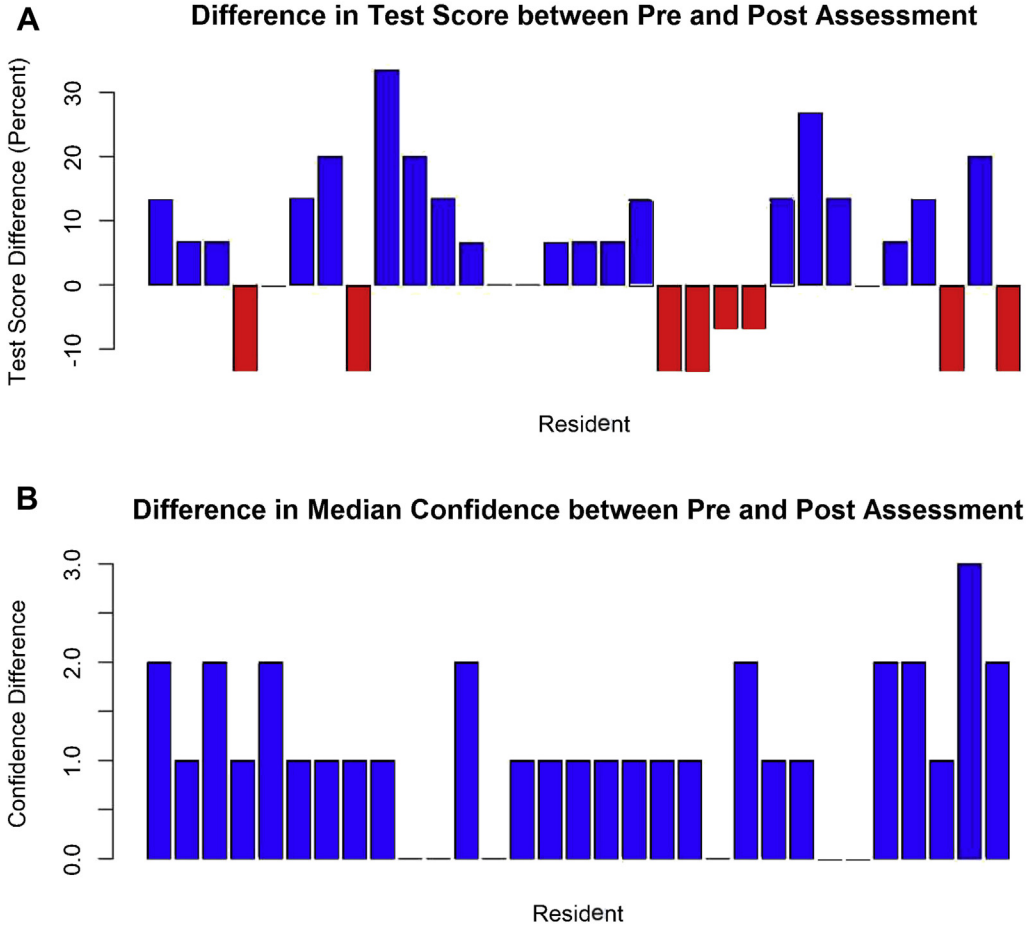

Figure 1. (A) The difference in knowledge test scores between pre- and postsurvey. Of the 31 respondents, 8 had lower overall test scores on second assessment and 4 received the same overall score. The maximum increase in score was 33%. Each bar represents a participating resident. (B) The difference in median confidence between pre- and postsurvey. Of the 31 respondents, 6 showed no improvement in confidence on the second assessment.

Subgroup analysis demonstrated that residents with prosthetic surgery experience of <10 cases (11 students) benefited the most (median difference of precompletion vs postcompletion scores = 6.67), whereas residents with >20 cases (6 students) did not increase their knowledge (median difference of precompletion vs postcompletion scores = 0), however this result was not significant (P value = .264). The biggest improvement (29.1% precompletion vs 90.3% postcompletion) in knowledge occurred in understanding the differences between the types of penile prosthesis (AMS, LGX, Ambicor, and Spectra [Boston Scientific, Marlborough, MA, USA]; Titan, Narrow base, and Genesis [Coloplast Men's Health, Minneapolis, MN, USA]). Residents also experienced a significant improvement (32.3% precompletion vs 77.4% postcompletion) in understanding when to use adjunct maneuvers for residual curvature secondary to Peyronie's disease and how to recognize and treat a proximal corporal perforation (25.8% precompletion vs 100% postcompletion).

A significant overall median improvement in confidence levels in performing penile prosthesis surgery was observed (4 vs 3, P value < .001). In addition, there was a significant improvement in median confidence levels in all questions (Table 2; P values < .003). One of the most important findings of this study was that 41.9% of participants did not feel confident placing the reservoir in the space of Retzius or in a submuscular location. However, by the end of the course, 90.3% of the residents reported feeling confident placing the reservoir. As voiced by the trainees during the course, this was the surgical step that was the most anxiety provoking. Figure 1B shows the difference in median confidence levels between pre- and postcourse surveys. Participants increased their confidence levels after the course regardless of their previous prosthetic experience (<10 cases vs >20 cases) (P < .01, data not shown).

The average cost of the simulation training course (airfare, lodging, meals, and meeting registration) was $1,483 per resident, which was possible because of an unrestricted educational grant from Coloplast and Boston Scientific.

DISCUSSION

Operative independence and autonomy in the operating room is essential to transition residents to independent, confident, and

Table 2. Confidence questions

	Prelab Assessment	Postlab Assessment	*P* Value
n	31	31	—
Overall Median Confidence (median [IQR])	3.00 [2.00, 3.00]	4.00 [4.00, 4.00]	<.001
Question 1 Confidence (median [IQR])	3 [3,4]	4 [4,5]	<.001
Question 2 Confidence (median [IQR])	3 [2,3]	4 [4,4.5]	<.001
Question 3 Confidence (median [IQR])	2 [2,3]	4 [4,4]	<.001
Question 4 Confidence (median [IQR])	2 [1,3]	3 [3,4]	<.001
Question 5 Confidence (median [IQR])	3 [3,4]	4 [4,4.5]	<.001
Question 6 Confidence (median [IQR])	3 [3,4]	4 [4,5]	<.001
Question 7 Confidence (median [IQR])	3 [2,3]	4 [4,4.5]	<.001
Question 8 Confidence (median [IQR])	3 [2,3]	4 [3,4]	<.001
Question 9 Confidence (median [IQR])	3 [2,3]	3 [3,4]	<.001
Question 10 Confidence (median [IQR])	3 [2,3]	4 [3,4]	<.001
Question 11 Confidence (median [IQR])	2 [1.5,2.5]	4 [3,4]	<.001
Question 12 Confidence (median [IQR])	3 [2,3]	4 [3,4]	<.001
Question 13 Confidence (median [IQR])	2 [2,3]	4 [3,4]	<.001
Question 14 Confidence (median [IQR])	3 [3,4]	4 [4,5]	<.001
Question 15 Confidence (median [IQR])	3 [2.5,4]	4 [3,4.5]	.003

The table shows the overall median confidence and median confidence per statement, in the pre- and postlab survey. The median confidence level was higher on the post survey (4 vs 3, $P < .001$). There was a significant difference in confidence between pre and post in all questions analyzed separately (all medians increased, all $P < .003$).
IQR = interquartile range.

competent practicing surgical urologists.[14] The development of these skills during residency could have been hampered by work-hour requirements, shorter training programs, increased supervision in the operating room, pressure to reduce procedure times, as well as public perceptions of resident roles in patient care.

A recent study suggested that the number of implantable penile prosthesis procedures performed in the United States has decreased in the last decade.[15] However, an aging U.S. population and a projected nationwide shortage of surgical urologists by the year 2030[16] will result in a critical need for well-trained urologists in prosthetic urology.[15] In addition, diminished operative confidence and competence in graduating urology trainees may further contribute to the already projected nationwide shortage of surgical urologists.

Urologic surgical training can also be significantly affected by inequalities in the availability of expert surgical educators. Urologic programs have different strengths and weaknesses based on their faculty subspecialties representation. Some areas of urologic expertise

may be overly represented although other subspecialties may not be well represented or could be even totally lacking. This is particularly the case in prosthetic urology where only an estimated 15% of urology training programs have a dedicated prosthetic urologist.[9] Cadaveric simulation training courses taught by an expert panel of high-volume prosthetic urologists may be used to overcome the existing educational training gap in prosthetic urology. The majority of the trainees who participated in this study were completing their second to last or last year of residency and only 20% of the trainees had an implant experience of <20 cases during their residency, which further documents the lack of prosthetic urologic training nationwide.

This prospective IRB study supports for the first time in urology that simulation surgical training and didactic lectures by expert proctors may be an effective educational method to improve knowledge and self-reported operative confidence in urology residents performing penile prosthesis surgery.

The findings in this study are consistent with prior studies in other surgical subspecialties investigating the benefits of practical, anatomic, and procedural training in cadaveric labs. Ahmed et al[17] was one of the earliest to demonstrate the feasibility, acceptability, high educational value, and cost-effectiveness of cadaveric simulation in urology. They confirmed the superiority of this method, establishing it as a potential solution to the challenges of providing efficient, safe, and effective urology surgical training.

It is unclear why 8 participants had lower scores on the follow-up assessment. Test consistency analysis was not performed. It is possible that residents felt rushed to complete the postlab assessment and did not commit the same effort as with the prelab assessment. A longer window to complete the assessment may have altered these results. Participants indicated more confidence in managing proximal corporal perforation; however, this was not confirmed in knowledge question 8 where there was an overall decrease in correct answers. This may have been because of the non-validated nature of the questions. Using a

psychometricist may have reduced the statistical error caused by poorly worded questions.

We should point out that subgroup analysis suggested that perhaps those trainees with the least prosthetic experience benefited the most in terms of improvement in procedural knowledge than their more experienced counterparts. The increased impact on more novice trainees highlights the tremendous need for training opportunities outside the operating room, such as this training course. We should focus our efforts in targeting those trainees whose residency programs lack an experienced high-volume prosthetic urologist and make programs such as this more accessible to them.

Although not captured in the data, a significant amount of resident anxiety was voiced during the course regarding the placement of the reservoir in the traditional space of Retzius. This is understandable given the blind nature of the step and the vital structures near the path of the reservoir placement. We believe that when given the opportunity to view these anatomic landmarks in a dissected cadaver in relation to the correct reservoir location, residents would feel more confident with performing this step in the operating room.

Despite encouraging results in terms of objective improvements in surgical knowledge and perceived confidence performing penile prosthesis surgery, our study has several limitations. First, this is a small survey study using a non-validated questionnaire. However, it is important to point out that the procedural knowledge questionnaire was based on the recommendations from the International Consultation on Sexual Medicine and was approved by the SUPS board.[13] There is no validated questionnaire for assessment of procedural knowledge or confidence with regard to penile implants. Another limitation is that participants completed the surveys shortly after the completion of the training course without having time to reflect on their training in clinical practice. Answers may have been influenced by emotion and most probably were biased by the short period between the course and the questionnaire. A period of time of at least a few weeks could reflect more realistic improvements in the confidence gained. A control comparing cadaveric simulation with a didactic instruction-only arm would have been helpful.

In addition, a more objective and hands-on evaluation is needed to determine if our methodology is valid for future studies. It is also worth considering that one of the reasons the faculty was so successful at increasing knowledge and confidence is that it was composed of known communicators of surgical teaching. Ideally, future studies should assess surgical skill using validated measures before and after simulation training. This would allow for a true demonstration of the transferability of the learned skills.

CONCLUSION

Simulation training of urology residents in penile prosthetic surgery improves surgical confidence and knowledge in a climate of increasing educational constraints and scarcity of expert prosthetic educators at a very reasonable cost. We expect that improvements in resident knowledge and surgical confidence will result in better resident performance. Based on this study, we strongly feel that simulation training in prosthetic urology is a critical component of urology residency. Further research is needed to better understand the benefits and limitations of cadaveric simulation training in prosthetic urology.

Corresponding Author: Aaron C. Lentz, MD, Associate Professor of Surgery, Duke University Division of Urologic Surgery, 3480 Wake Forest Road, Raleigh, NC 27609, USA. Tel: 919-862-5600; Fax: 919-862-5610; E-mail: aaron.lentz@duke.edu

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STATEMENT OF AUTHORSHIP

Category 1

(a) Conception and Design
Aaron C. Lentz, Ricardo Munarriz, Gerard Henry, Leroy Jones, Rafael Carrion

(b) Acquisition of Data
Aaron C. Lentz, Ricardo Munarriz, Dayron Rodriguez, Leah G. Davis

(c) Analysis and Interpretation of Data
Aaron C. Lentz, Ricardo Munarriz, Dayron Rodriguez, Leah G. Davis, Price Kerfoot

Category 2

(a) Drafting the Article
Aaron C. Lentz, Ricardo Munarriz, Dayron Rodriguez, Leah G. Davis, Michel Apoj

(b) Revising It for Intellectual Content Writing
Aaron C. Lentz, Ricardo Munarriz, Dayron Rodriguez, Leah G. Davis, Michel Apoj

Category 3

(a) Final Approval of the Completed Article
Aaron C. Lentz, Ricardo Munarriz, Paul Perito, Gerard Henry, Leroy Jones, Rafael Carrion, John J. Mulcahy

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SUPPLEMENTARY DATA

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