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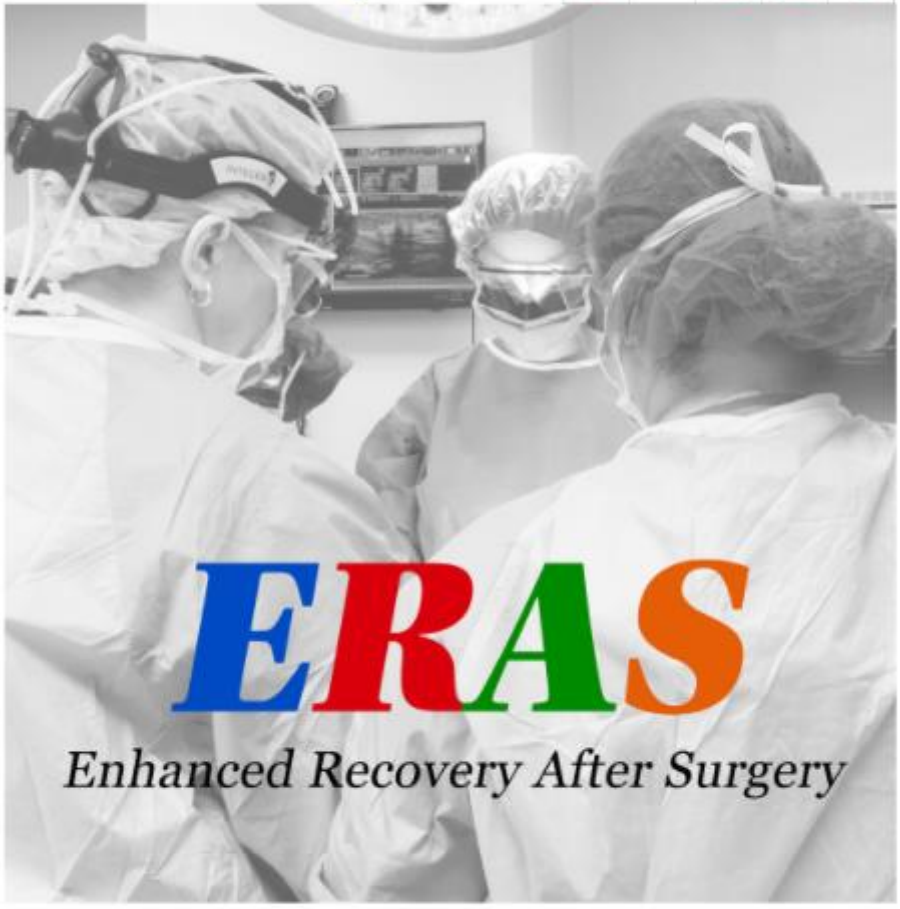

美国华人麻醉医学会期刊
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记得不久前ERAS的概念才提出，现在很多医院已经推广应用了。减少术后并发症和麻醉的副作用，促进病人术后康复，是一条健康的大道，秋收的大道。

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主编之言

本期主题

Jack Zhang

感谢麻浩波医生为本期组稿和各位同仁供稿。

欧美医疗界已经推广ERAS已有一段时间，众多亚学科展开了相应的研究来验证ERAS的临床效果。肛肠外科、妇产科、心外科、耳鼻喉科和骨科等大部分学科已经确定了ERAS的短长期疗效。麻醉医生在围术期尤其麻醉管理地位尤为重要和突出。

与传统的围术期相比，ERAS的好处是，减少疼痛，减少阿片类药物使用、住院时间、护理时间和费用，同时改善功能结局、患者满意度和生活质量。遵守标准化的ERAS规定也能降低并发症的发生。这些优点已经在肛肠外科、妇科手术和剖宫产得到证实。

ERAS的主要缺点是，ERAS缩短了患者住院时间，减少了患者获得信息和教育的机会，并增加出院后并发症或再入院率。

ERAS规程在亚专业、手术途径和医疗机构之间有所不同。一般而言，加强康复的重点在于优化患者的教育和围手术期期望，减少围手术期的禁食期，维持正常体液和体温，增加活动，提供多模式镇痛，预防恶心和呕吐，以及减少不必要或长期使用导管和引流器。作为多学科团队努力的一部分，麻醉医生的围术期中的麻醉相关管理将影响短长期术后结局。

ERAS在全球已扎根生花，其中海外华人医生也积极推动ERAS的理念和实践，中国许多三甲医院已经成功地开展ERAS。我衷心希望本期的ERAS内容将有助于CASA推广和造益于广大患者。

参考文献

Grant MC, Pio Roda CM, Canner JK, Sommer P, Galante D, Hobson D, Gearhart S, Wu CL, Wick E The Impact of Anesthesia-Influenced Process Measure Compliance on Length of Stay: Results From an Enhanced Recovery After Surgery for Colorectal Surgery Cohort. Anesth Analg. 2019;128(1):68.

Liu JY, Wick E C Enhanced Recovery After Surgery and Effects on Quality Metrics. Surg Clin North Am. 2018;98(6):1119. Epub 2018 Aug 24.

Jack Zhang, 鲁开智，欧美国家门诊膝关节置换术简介和麻醉镇痛进展。中华创伤杂志 2018.34(1)：73-77

ERAS

ERAS 的起源与发展

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2001年，英国爱丁堡大学Ken Fearon教授和瑞典卡罗林斯卡研究院Olle Ljungqvist教授在伦敦的营养学会议时会面，他们一起讨论想合作为围术期做些什么。在丹麦哥本哈根大学Henrik Kehlet教授90年代提出的“术后恢复一些建议”的基础上，2001-2004期间他们成立了“ERAS研究团队”(Enhanced Recovery After Surgery, ERAS Study Group)，也即国际加速术后康复协会“The ERAS Society”的前身，正式提出了“多模型外科管理”(the multimodal surgical care)的概念。但研究组成员很快发现，不同的医院科室使用不同的传统医疗模式，实际做法与已知的最佳实践方法之间存在很大的差异。这就促使了该小组研究，极力倡导改变传统医疗模式，推广最佳实践(best practice)的模型。

最早成功的范例是结肠外科的ERAS指南（Fearon et al. Clin Nutr 2005;24:466-477），现在已被广泛的采用和推广，几乎涵盖了所有的外科分支专业，例如：结肠外科、泌尿外科、妇科手术、肝胆外科、乳腺外科、减肥手术。成功的ERAS必须是：多模式的康复，循证医学，全程患者状况的优化，包括术前、术中、术后。

实行推广ERAS需要多学科的合作，包括外科医生门诊、麻醉门诊、麻醉、PACU、术后病房，需要改变传统的医学模式、改变医疗文化、甚至需要改变医院的组织结构或经济效益的得失。可见，成功的实行ERAS是依靠医护人员高度的依从性、有效解决问题的能力。

实行ERAS能够促进患者早日恢复，明显缩短住院的时间（Br J Surg 2007;94;224-231），提高患者的满意度。但提早出院可能导致重新入院率增加。至今，还没有数据表明ERAS可以降低围术期的死亡率。

2018年，美国妇产科学会发表了剖宫产ERAS指南（Am J Obstet Gynecol 2018;219:533-544），旨在提供最佳实践、循证医学的指南，着重于产妇的康复。它分为三部分：剖宫产术前、术中、术后。对于产科麻醉医生而言，我们担负了很大部分的责任，包括：抗菌素的使用、麻醉方式的选择（首选椎管麻醉）、早期术后疼痛的管理、预防术中低温、液体的管理。

2019年，我们医院实行剖宫产的ERAS。其实，在此之前我们早已实行了剖宫产的ERAS。所以对麻醉医生来说，需要改变的非常少。需要指出的是：

阿奇霉素(Azithromycin)的使用：对于中转剖宫产的产妇、或者已经破膜的产妇，及时使用500毫克阿奇霉素，静脉点滴1个小时。阿奇霉素可以明显引起恶心呕吐，应提早给与恩丹西酮，静脉缓慢

点注可以减轻症状。

中转剖宫产的产妇，寒颤发抖比较常见，产妇感到非常不舒服。临床上，我们主张积极治疗：胎儿娩出后，给予右美托咪定(Dexmedetomidine)，10微克，静脉注射，可重复使用至总量30微克。

如果没有禁忌症的话，在剖宫产结束之前，给予静脉30毫克酮咯酸(Ketorolac)。

在此，我将提供我们医院的剖宫产ERAS, 供参考。指南的作者为：Lindsay Sween, MD, Philip Hess, MD

感谢美国华人麻醉学会杂志提供的平台，大家可以相互交流。感谢CASA杂志主编、编委、ERAS专辑的特邀麻浩波医生的组稿和辛勤工作。

Enhanced Recovery After Cesarean Delivery CarePath

	Scheduled Cesarean CarePath	Unscheduled Cesarean CarePath
Goal	Increase patient satisfaction and outcomes by reducing post-op pain, nausea/vomiting, time to void and time to ambulation by minimizing opioids and maximizing alternative medications and techniques	
To whom it applies	Patients with scheduled cesarean sections at BIDMC	Patients with unscheduled cesarean sections at BIDMC (e.g. intrapartum)
NPO guidelines	Patients should keep their usual diet until midnight on the night before surgery. They may have a light, low fat snack (e.g. crackers or one slice of dry toast) up to 6 hours prior to surgery. They may have clear liquids up until 2 hours before surgery. Patients will be instructed to drink a non-carbonated, non-particulate 45-gram carbohydrate beverage (e.g. Gatorade or apple juice) up to two hours prior to surgery for nondiabetic patients.	Patients should be NPO as soon as the decision for cesarean section is made. Depending on the urgency of delivery, the anesthesia and obstetric team will discuss appropriate timing based on last intake. If patients have neuraxial anesthesia during labor, their diet should be changed to clear liquids at time of placement.
Pre-op (anesthesia)	Anesthesia assessment	
Intraop (anesthesia)	- Antibiotics within 60 minutes of skin incision (Cephalosporin preferred. Add azithromycin if patient in labor or membranes ruptured) - Regional anesthesia preferred method - Aspiration prophylaxis with non-particulate antacid - Appropriate patient monitoring - **IV fluid warming** and increased OR temperature to at least **68°F** are recommended to prevent hypothermia in patients under neuraxial anesthesia; forced air warming can be added for patient	

Breast and Plastics CarePath

Owner: Dr. Eswar Sundar
Review Date: Dec. 2018
Next Review Date: Dec. 2021

	Extended Mastectomy/ and or any Plastic Reconstruction of the Breast or Face	Lumpectomy/ Partial Mastectomy
Goals	Reduce PACU length of stay and increase patient satisfaction by reducing post-op pain, PONV, and sedation by minimizing opioids and incorporating a multimodal analgesic regimen.	Reduce PACU length of stay and increase patient satisfaction by reducing post-op pain, PONV, and sedation by minimizing opioids and incorporating a multimodal analgesic regimen.
To whom it applies	• Axillary node dissections • Simple mastectomies • Any plastic surgery except free flaps. Includes IP, SDA and outpatients	• Partial mastectomies without axillary node dissection. • Breast cases using MAC sedation. • Includes IP, SDA and outpatients.
Meds ordered night before	• Gabapentin 300-400 mg PO x 1 OR • Pregabalin 25-75 mg PO x 1. • Acetaminophen 1000mg PO x 1 • Celecoxib 400mg PO (except for facial plastics) • Scopolamine Patch for PONV	• NO Gabapentinoids • Acetaminophen 1000mg PO x 1 • Celecoxib 400mg PO
Consider a holding area huddle: between surgeons, patient and anesthesia to discuss:	• PO meds administered in holding area. • Prescriptions that the patient will take home (so that PACU orders can be coordinated).	• PO meds administered in holding area. • Prescriptions that the patient will take home (so that PACU orders can be coordinated).
Blocks	• All cases that need a block will be booked as such. if not booked as a block, surgeon will infiltrate locally. • Suggested guideline for blocks: All mastectomies if booked and combined cases if booked as such.	

Induction	Dexamethasone 8mg IV SLOW.	• Dexamethasone 4mg IV SLOW. • MAC anesthesia if appropriate.
Surgeon	If block not performed, surgeon to instill local anesthetic into wound as appropriate	Surgeon to instill local anesthetic into wound as appropriate
Intraop	• NO Ketorolac • Ondansetron 4mg IV at end of case. • Minimal opioids. Short acting (Fentanyl or Dilaudid in low doses)	• Consider Ketorolac if Celecoxib has NOT been given at end of case • Ondansetron 4mg IV at end of case
Consider using:	Esmolol Infusion in place of opioids. 10 mcg/kg/min, adjusted 5-15 mcg/kg/min based on HR. Start during induction, end with removal of airway device	
PACU	• PO Opioid as needed when able to tolerate PO. • IV opioid (fentanyl or hydromorphone in low doses) for breakthrough pain, if unable to tolerate PO, or VAS>5.	• PO Opioid as needed when able to tolerate PO. • IV opioid (fentanyl or hydromorphone in low doses) for breakthrough pain, unable to tolerate PO, or VAS>5

Orthopedics Outpatient Sports medicine and Foot/ankle CarePath

Policy Owner: Dr. Eswar Sundar,
Director of Clinical Operations- East
Review Date: Dec 2018
Next Review: Dec 2021

	Orthopedics Outpatient Sports medicine and Foot/ankle CarePath
Goal	Reduce PACU length of stay and increase patient satisfaction by reducing post-op pain, PONV, sedation and time to void by minimizing opioids and maximizing alternative medications and techniques.
To whom it applies	Outpatient Arthroscopy and reconstructive procedures
Meds for holding area	Anesthesia team the previous evening
What Meds to order	• Acetaminophen: 1000 mg PO. Consider 500 mg in patients<50 kg. Contraindications: cirrhosis or severe liver dysfunction, allergy or if taken in the previous 6 hours (e.g. Percocet, Vicodin) • Pregabalin: 25-75 mg PO, Indicated for patients getting, shoulder surgery, hip osteoplasty, ACL reconstruction, foot and ankle reconstruction. Avoid preoperative Pregabalin in straight knee arthroscopies and hand and arm surgery under block, bunionectomies, ankle arthroscopy, simple hardware removal (wires, screws). Contraindications: Renal failure on dialysis or known CrCl < 30 mg/dl, allergy • If patient chronically on Gabapentin or Pregabalin, patient can take their am dose instead. Side effects: sedation, dizziness, blurred vision.
Consider having a Holding Area Huddle	Preop Mini-discussion between Anesthesia, Ortho Team members and the Patient addressing: Holding area premeds the patient has taken. Prescriptions the patient has (to order appropriate PACU meds)
Regional	Nerve Block Plus

Anesthetic	• General Anesthesia with the airway management of your choice. Avoid opioid use especially when patient has a complete nerve block (ie. shoulders) • Small dose ketamine (0.1 mg/kg) after induction may be helpful to decrease hyperalgesia for patients with incomplete nerve blocks (i.e. ACL, Knee scopes). • or MAC's for Shoulders done in beach chair, hand procedures with good block if appropriate.
At induction	Dexamethasone 8 mg IV slow
Intraop medications	• Ondansetron at the end of the case. • Use Hydromorphone or Fentanyl sparingly. • May need Phenylephrine infusions to raise the BP in a Beach chair position to reduce the risk of neurological injury. • Ketorolac 30 mg IV. Please discuss with surgeon before administration. Contraindicated in renal insufficiency, known platelet disorders, allergy.
PACU analgesia	• PO narcotics preferred • Ketorolac 30 mg IV. If not administered before • Hydromorphone (0.1-2 mg) or small doses of Fentanyl (<100 mcg) for breakthrough pain. • Consider reblocking early if pain is severe.
Postop meds ordered by Ortho	• Oxycodone/Vicodin • Acetaminophen • NSAIDS (some patients) • MSContin (selected patients for shoulder or foot reconstruction)

Orthopedics Inpatient/SDA Total Joint Arthroplasty Carepath

Owner: Dr. Eswar Sundar
Review Date: Dec. 2018
Next Review Date: Dec.2021

Goals	Improve analgesia through increased applicationof multimodal analgesia. Decrease risks and complications in patients having total knee and hip arthroplasty.
To whom it applies	All SDA and IP total knee or hip replacement patients (total shoulders with some variations)
PAT Role	• Labs • ECG • MRSAswabs • Patients watch video or attend class • PAT attending or resident will consent patients for TJA (spinal, blocks, GA) • Holding Area meds ordered (if not ordered by PAT for any reason the anesthesia team orders them the day before surgery)
What holding area meds to order	• Acetaminophen:1000mgPO. Consider500mg in patients<50kg. --Contraindications: cirrhosis or severe liver dysfunction,allergy • Pregabalin: 25-75 mgPO. --Contraindications: Renal Insufficiency, allergy • --if patient is chronically on Gabapentin or Pregabalin, patientcan take their am dose instead. Side effects of Gabapentinoids: sedation, dizziness, blurred vision. • If patient is chronically on oral opioids the patient is given their scheduled Oxycontin, MScontin or Methadone if not taken prior to arrival tohospital. • Start Vancomycin infusion if indicated.
Holding Area Huddle.	• Antibiotic choice • Choice of anesthesia type (if epidural or selective tibial block is required) • Any Tranexamic Acid (TXA) contraindications • Other concerns (complexsurgeries,uniquepatientissues, difficult airways.
Regional for post op pain relief	Nerve blocks done by blockteam: Femoral (Doug Ayres acses) or Adductor canal block: all patients havingTKA. Epidural placed either by team or block team (selected cases).

Drugs at induction or start of neuraxial anesthetic	• Tranexamic acid(TXA): Dose:1gm over 20 min if >60kg or 10mg/kg over 20 min if<60 kg. TXA must be completed before tourniquet inflation. Contraindications: Allergy, Chronic anticoagulation, history of VTE. • Antibiotics:Patients should complete antibiotics prior to incision. • Cefazolin: 2gm IV if under120kg, 3gm if patient>120Kg. • Vancomycin: 1gm - 1.5 gm for patients allergic to cefazolin and MRSA. Start in holding area and administer over 60minutes (1.5 gm for patients > 90kg) • Vanco allergic patients with MRSA: discuss with surgeon,check antibiotic guidelines
Choice of Anesthetic	Spinal is the preferred anesthetic
Anesthetic	• Spinal Anesthetic: Use isobaric bupivacaine alone(12-15 mg). NO additional opioids, or Ropivacaine 0.5% 3.5ml for total knee arthroplasty. • CSE: Useful when requested for postoperative analgesia, when more prolonged procedure, or in patients of extremes of size or age. • AVOID: opioids and anyother additional narcotics • If epidural has also been placed, use it for postop analgesia instead of opioids and sedatives. • Ketorolac: 15-30 mg after drains placed or at end of procedure. (Dr. Abdeen gives ketorolac 15 mg with her localat the end of the case. Reduce or avoiding IVdose.) • Sedation: Midazolam, Propofol in doses just enough to allow thepatient to be arousable.
PONV prophylaxis	PONV: this patient population is lower risk for PONV. Ondansetron Minimize use sedating agents which can contribute to delirium (promethazine).
PACU Pain management	• Oral opioids should be the main stay of pain management. Administer PO opioids as soon as patients can take PO's. • Oxycodone: 5-15mg • PO Hydromorphone: 2-4mg • Highly tolerant patients should receive their scheduled analgesic drugs as well as additional short-actingnarcotics. • **Adjuvants to painmanagement** • NSAIDs: if not given in OR. • Acetaminophen: 1000 mg if not givenpreoperatively • Pregabalin: 25-75 mg if not givenpreoperatively • Dexamethasone 6-10 mg in appropriatepatients • Regional anesthesia supplementation in theP ACU • TKA with pain: considersciatic block for patients with kneepain. (Consult APS) • THA with pain: consider Lumbar plexus block (contact APS) • **Treatment of spasm** • Cyclobenzaprine(Flexeril™) 5mg PO. Side effects sedation, delirium • Lorazepam (0.5-2mg) PO or IV. Also useful for anxiety. IV Opioids only when above do not work.
Discharge criteria for neuraxials	Level below T12, (able to move feet and/or bend non-operative knee) and patient has reached PAR criteria.

Gyn Carepaths

SOP #: ANES CLN 100-018

Policy Owner: Dr. Eswar Sundar,
Director of Clinical Operations
Review Date: Dec2018
Next Review: Dec2021

	Gynecologic Laparoscopy CarePath	**Gynecologic Hysteroscopy CarePath**
Goal	Reduce PACU length of stay and increase patient satisfaction by reducing post-op pain, PONV, sedation and time to void by minimizing opioids and maximizing alternative medications and techniques.	same
To whom it applies	All Gyn patients (OP, SDA, IP) who are getting a laparoscopic or hysteroscopic procedures. As always check contraindications and precautions for specific drugs before ordering or administering.	same
NPO	Patient should not eat any solid food after midnight but they may havelimited clear liquids (less than 12 ounces) up until 2 hours before the arrival time at thehospital. This approach allows for potential changes in scheduling.	same
Order meds Previous evening in POE	• Gabapentin 300 PO x 1 OR Pregabalin 25-50 mg PO x1. • Acetaminophen 1000mg PO x1 • NO ScopolaminePatch • NO Celebrex	• NO Gabapentinoids • Acetaminophen 1000mg PO x1 • NO Scopolamine Patch • NO Celebrex

Holding area Huddle	• Preop Mini-discussion between Anesthesia, Gyn Team members and the Patientaddressing: • Inform GYN and patient of pre-meds ordered/received, so that maximum daily acetaminophen dosing is not exceeded. • Discuss whether there is a need for an orogastric or nasogastric tube to decompress the stomach. • Discuss what analgesic prescriptions the patient is going home on, so that PACU orders can becoordinated. • Gyn to handover scripts to relative and inform holding area RN. • Any issues with Med Reconciliation brought up by Gyn and/or patient (e.g when to restart anticoagulants) • Consider consenting for post-op TAP block if there is possibility for converting to open procedure.	• Preop Mini-discussion between Anesthesia, Gyn Team members and the Patient addressing: • Inform GYN and patient of pre-meds ordered/received, so that maximum daily acetaminophen dosing is not exceeded. • For D&C, D&E, discuss whether doxycycline PO has been ordered and given (be sure to document in tab 14 on AIMS) • Discuss what analgesic prescriptions the patient is going home on, so that PACU orders can be coordinated. • Gyn to handover scripts to relative and inform holding area RN. • Any issues with Med Reconcilliation brought up by Gyn and/or patient (e.g when to restart anticoagulants)
Induction	Dexamethasone 10mg IV SLOW.	Dexamethasone 4mg IV SLOW.
Intraop (surgeon)	Surgeon to infiltrate port sites with local anesthetic, before placement and before closure. Instill 100 cc of fluid in bladder before removal offFoley.	
Intraop (Anesthesiologist)	• Ketorolac 30mg IV at beginning of vaginal cuff closure/~1 hour prior to end of case. • Ondansetron 4mg IV x 1 with removal of instruments • Judicious use of IV fluids. • Judicious use of opioids. Short acting (Fentanyl or Dilaudid in low doses) preferable. • Esmolol Infusion in place of opioids. 10 mcg/kg/min and can be adjusted 5-15 mcg/kg/min based on HR. Start during induction and end with removal ofairway device.	
PACU Nursing	• Voiding Protocol per guideline • PO Opioid when able to tolerate PO. • IV opioid (fentanyl or dilaudid in low doses) until toleratingPO.	NO Voidingprotocol PO Opioid when able to tolerate PO. IV opioid (fentanyl or dilaudid inlow doses) until toleratingPO.

Colorectal Surgery Carepath

Owner: Dr. Eswar Sundar Review
Date: Dec. 2018
Next Review Date: Dec.2021

Goals	To attenuate the stress response to surgery by using a minimally invasive approach as far as possible. Reduce protein catabolism by minimizing the fasting state and encouraging carbohydrate loading. Decrease the incidence anastomic breakdowns and hasten the return of normal bowel function by adoption a fluid and opioid restrictive strategy.
To whom it applies	Open, laparoscopic and robotic elective colorectalsurgery.
NPO Guidelines	Carbohydrate loading: Patient will be ingest carbohydrate gel the day before surgery and 2 hour prior to check in the day ofsurgery Fasting: No solids after midnight Clears up until 2 hours prior to check in
Meds ordered night before	• Gabapentin 300-600mg PO x 1 OR Pregabalin 75mg PO x1. • Acetaminophen 1000mg PO x1 • Avoid Scopolamine patch • Avoid Benzodiazepines unless clearly indicated for anxiety or the need to do a procedure in the holding area.
Induction	• Low dose opioid with induction only (consider 50-100 mcg fentanyl or 0.2-0.4mg dilaudid) • Decadron 8mg IV post induction (caution in diabetics)
Intraop (Surgeon)	Transverse abdominis plane block performed prior to closure by surgeons (bupivacaine 0.25% + epinephrine @1cc/kg)
Intraop (Anesthesiologist)	• Antibiotic prophylaxis: (Cefazolin 2gm q 4hrs and Metronidazole 500mg (1gm for BMI>40) q 6hrs) • Positioning: Arms are tucked for laparoscopic and robotic procedures. Consider obtaining a second peripheral IV. Extension on IV set will be needed. Recommend disposable pulse oximetry sticker to prevent dislodgment when hands aretucked. • OGT post induction. Removed at end ofcase.

Fluid management	• Start 1 Liter LR in preop area to be infused and completed by post induction. Caution in patient's who are unable to tolerate the 1L fluid bolus • Maintenance: 3cc/kg/hr IBW (laparoscopic); 5cc/kg/hr IBW(open). • Ideal Body Weight (IBW) determination guide: 60 inches:45kg 65 inches:60kg 70 inches:70kg 75 inches:85kg • Don't chase UOP during laparoscopic approach unless UOP is <0.5cc/kg/hr for 6 hours at which point terminate the pathway. • For intraoperative hypotension in the absence of blood loss consider using vasopressors instead of giving additional fluid. If additional volume resuscitation is felt to be necessary consider colloids instead of crystalloids. • In the case of significant blood loss consider termination of pathway.
End of Case:	• Ondansetron 4mg at end of case, • Metoclopramide 10mg at end of case (also helps with gastric motility), 5mg for patients 65-75 years old. Do not use in age >75 year old and patients with Parkinson'sdisease. • Ketorolac 30 mg IV.
PACU	• Sign out to nursing that we are using a fluid restrictive strategy in this patient • Pain Management: • Dilaudid boluses per anesthesia post op orderset • Tylenol 1gm IV if due (should have been administered preop) • Toradol15-30mg IV if due (should have been administered intraoperatively)

综述

一氧化氮（NO）临床用途及麻醉

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前言

什么是一氧化氮(NO)? NO是化学元素氮与氧（O2）氧化而成的无色无味气体。NO也可与O2和臭氧（O3）反应形成二氧化氮（NO2），一种有毒的环境污染物。众所周知NO存在于自然界；工业、发电厂、汽车发动机和实验室也可产生NO。1992年，《科学》杂志将NO评为“年度分子”。NO的生理重要性已经在神经科学、生理学和免疫学领域得到揭示[1]。1998年，Robert F. Furchgott，Louis J.Ignarro和Ferid Murad因其阐明NO在心血管和神经系统中的信号作用而获得了诺贝尔生理学和医学奖。

自从Joseph Priestly在1772年发现NO以来，其历史重要性不言而喻。它是为数不多的气体信号分子之一，其对细胞信息传递是细胞生长，分化和功能的基础[2]。NO具有高反应活性，其半衰期只有几秒钟，这对患者的麻醉管理至关重要。1867年首次被Dr.Brunton[3]用于治疗心绞痛的amyl nitrite一世纪后已被广泛证明是NO供体以发挥扩血管作用。

Murad博士最早进行了NO实验。他证明NO气体可以激活鸟苷酸环化酶（GC）来催化鸟苷3', 5'-环一磷酸(cGMP)的转化，从而建立NO-cGMP途径。而Furchgott博士在功能正常的血管内皮细胞层中发现了一种与内皮细胞相关的舒张因子（EDRF）。最后Ignarro博士确认EDRF即为NO，并确定哺乳动物细胞产生NO[4-5]。至此以后，每年均有大量NO研究论文问世发表。

1991年，Warren Zapol博士，一名麻醉医生及其研究小组率先开展了吸入性NO（iNO）的研究。研究人员对一名患有持续性肺动脉高压的新生儿（PPHN）进行了最早的试验治疗，证明NO是选择性的肺血管扩张剂。之后，许多研究人员在全美范围内用动物和人体iNO双盲随机试验治疗急性呼吸窘迫综合征（ARDS）和原发性肺动脉高压PPHN证实了其有效性[5-10]，因此在1999年FDA正式批准iNO临床使用。

近年来，iNO已常规用于治疗PPHN新生儿[4-9]，药品批准外用药（off label）的其他使用：如ARDS[8-9, 11-13]，肺动脉高压成年患者[9, 14-17]，输入人造红细胞或老化红细胞[18-19]并调节免疫反应，包括最近，防治冠状病毒[20-22]等都作为与其他药物联合使用或作为辅助“救援疗法（rescue therapy）使用。

在过去的几十年中，iNO的临床使用显着增加，麻醉医生对NO的特性及其生理作用和临床应用的理解也至关重要。

人体组织内NO的生物合成及其功能

NO是由一氧化氮合成酶（NOS）合成产生的内源性分子，产生后极易扩散至周围组织中。NOS具有三种同工型酶体，分别为神经源型，诱导型和内皮型NOS，也即1，2和3型NOS。此酶是一种含血红素的氧化还原酶，它通过一系列复杂的酶结合化学步骤从L-精氨酸的末端胍基氮和氧合成NO。三种NOS酶具有独立的功能：内皮型（eNOS）和神经元型（nNOS）其发挥正常功能需钙的参与，并且作为细胞信号分子产生的NO含量低。诱导型（iNOS）非钙依赖性，主要在炎症/组织受损时的炎性细胞中表达[23-26]。

NO由血管内皮细胞内的eNOS合成释放后扩散到血管平滑肌细胞中，从而导致血管舒张，进而增加血流量并降低血压[4,24,26-27]。在细胞内NO与可溶性鸟苷酸环化酶（GC）蛋白中的血红素基团结合，从而增加了第二信使鸟苷3', 5'-环一磷酸（cGMP）的产生，进而激活依赖于cGMP的蛋白激酶G（PKG）而增加细胞内钙再摄取，降低细胞内钙离子浓度；激活钾通道导致细胞超极化，最终肌球蛋白轻链激酶不能磷酸化肌球蛋白轻链，从而阻止了肌球蛋白横桥运动并导致平滑肌细胞松弛。因而NO被称为主要的内源性血管张力调节剂[8,26,28]。

神经元和神经胶质细胞可以表达nNOS，主要产生脑中的NO，而NO作为脑中的一种特殊递质，在许多种经回路中用于调节功能（例如记忆和学习）[26,29]。

免疫系统中由iNOS合成的NO在生理条件下具有多种作用，包括抗增殖和抗炎作用。而在病理状态下，巨噬细胞会产生并大量分泌NO，这些自由基破坏细菌、寄生虫、病毒和其他异物[26,30-31]。

除了上述NO的作用外，NO在调节胃肠道的各种功能方面也起着关键作用，例如通过调节黏膜的抵抗，分泌和平滑肌功能来维持粘膜完整性[32]。

血红蛋白与NO高亲和力结合形成硝酸盐和高铁血红蛋白而使其在血液中迅速代谢失效，半衰期仅为数秒，结合率高低取决于血红蛋白的状态（R或T）。这阻止了NO从内皮细胞向其他细胞的弥散[4,19]。在红细胞内，高铁血红蛋白还原酶将高铁血红蛋白转化为亚铁Hb[7,33]。因此，NO是一种快速代谢的不稳定分子，无法储存在人体中。而硝酸盐是NO和NO供体/载体的主要存储形式[27]。

iNO与临床使用

1. iNO用于小儿/成人肺高压和急性呼吸窘迫症

儿童肺动脉高压的病因与成人不同，多为特发性，先天性心脏病和肺发育不全所致。少见的儿童肺动脉高压（PAH），即新生儿持续性肺动脉高压（PPHN）在出生后不久即被诊断，其病因及病理机制尚不明了，主要是肺血管的异常收缩、血管床发育不良所致。诊断肺高压的指标与成年患者相似，即静止时平均肺动脉压大于25mmHg，肺血管阻力增加大于3Wood/m^2[27]。

1990年，Zapol博士及其小组在清醒羊羔体内用药物诱发肺动脉高压进行实验研究。他们切开羊羔气管使之吸入60%O2/iNO 5-80百万分率（PPM）混合气体，期望可降低肺动脉压力。他们观察到羊

然吸入iNO30秒后,其肺血管舒张和肺动脉阻力降低，而全身动脉血压无变化，也未出现高铁血红蛋白血症或肺损伤[5,6]。此后，他的小组开始了iNO的开拓性临床试验，以治疗患有原发性肺动脉高压的缺氧新生儿，即“蓝色婴儿”。这类缺氧新生儿吸入的iNO快速扩散到肺间质中，在进入血流前扩张肺毛细血。几分钟之内“蓝色婴儿”变成“红色婴儿”。最重要的是，婴儿在吸入iNO时，肺动脉压力和PaCO2下降，血氧饱和度上升，但全身BP并未下降。他们还发现，患者可安全的吸入O2/NO混合气体而无明显有毒二氧化氮（NO2）产生[4,6]。之后iNO也开始在美国和其他国家尝试治疗儿童肺高压引起的缺氧性呼吸衰竭[5, 7-9]。

截至目前为止，临床上iNO仅被批准用于肺动脉高压的新生儿（妊娠>34周），所有其他儿童和成人患者使用均为off-label。iNO 10-80 ppm可作为辅助“救援疗法”与其他药物一起用于成人肺动脉高压患者。这些患者吸入iNO后肺动脉压降低和肺血管阻力降低，但心输出量，全身血压未降低，NO2浓度也未见明显增加。iNO还通常用于治疗慢性肺动脉高压恶化引起的急性肺动脉高压危象以及严重的肺栓塞，心脏手术和肺切除手术引起的急性右心衰竭[14-17]。然而iNO的广泛应用仍然存在一些实际问题：1）成本高；2）突然停药导致患者出现血管收缩和肺动脉高压反跳现象，从而加剧低氧血症；3）机械设备故障（包括NO气体耗尽，管道扭结，断开或阻塞输入管以及无法连接至iNO输入管）均会导致iNO吸入中断[7,8, 16]。

除iNO外，还有其他多种吸入性肺血管舒张剂，例如前列环素，主要由血管内皮细胞产生，是已知的有效血管舒张剂。前列环素类药可增加血管内皮平滑肌细胞中的cAMP浓度并激活蛋白激酶A（PKA）。PKA促进肌球蛋白轻链激酶的磷酸化（该酶使平滑肌肌球蛋白轻链磷酸化并引起收缩），从而导致平滑肌松弛和血管舒张。证据表明这些药物在增加氧饱和度和降低肺血管阻力方面与iNO一样有效。目前，前列环素类药物吸入装置尚未达到具有安全功能装置的iNO程度(持续监测O2，iNO和NO2浓度，备用输送系统，iNO或NO2浓度达到设定范围时的警报系统，备用电源等)。此外，由于效果和成本有限，它们尚不能作为一线用药[7,8, 17]。其他血管扩张剂，例如钙通道阻滞剂，β-肾上腺素能激动剂，硝普钠和硝酸甘油，都是非选择性血管扩张剂，它们难于静脉滴定至所需效果，扩张肺动脉同时也扩张其他血管而致全身动脉压降低[14-16]。

急性呼吸窘迫症（ARDS）是危及生命的一系列严重疾病综合征，多由败血症，肺炎，严重创伤和大量输血所致。ARDS临床上可致肺动脉高压,肺水肿和右心室功能障碍，肺内通气血液分流量增加，通气-血流比例失调和肺顺应性降低而致严重缺氧血症[11-12, 25, 34]。

1993年，Abman等人首先使用iNO治疗感染引起的ARDS低氧早产儿[35]。随后开展了许多随机对照试验（RCT），研究表明iNO通过选择性地调节肺通气较好区域中的血管舒缩力可逆转通气-血流比例失调，改善PaO2/FO2比率，降低肺血管阻力，肺动脉高压和右心负荷。iNO似乎不会干扰肺表面活性物质，还具有消炎和抗氧化作用。因此，iNO可增加肺顺应性，潮气量并降低气道阻力[8, 11]。

然而，研究表明iNO似乎并未提高ARDS患者的生存率。iNO疗法不会直接减轻肺损伤的程度，对ARDS，炎症表现，多器官功能障碍和免疫抑制的发病也无逆转作用[8, 11, 13, 36]。在成人ARDS患者中，iNO作为一种辅助的“救援疗法”，可以暂时，迅速地改善氧饱合度。严重的ARDS需要肺复张的多种措施治疗（Lung recruitment maneuvers）:如俯卧位，吸入NO或其他肺血管扩张剂，限制静脉输入液体量，高频振荡通气和体外膜氧合技术（ECMO），以及其他治疗以改善氧饱合度[12-13, 37]。

2. NO和红细胞/血红蛋白在NO稳态中的作用

内皮细胞内eNOS产生NO以扩张血管平滑肌细胞。NO量减少会引起血管收缩，组织血流量降低和引起炎症[25,33]。红细胞（RBC），血红蛋白（Hb）对于调节血管内NO的生物利用度至关重要。在正常情况下，红细胞内血红蛋白迅速清除扩散进的NO并终止其生物活性。RBC溶血时，如某些疾病或老化RBC输血，血管内溶血会释放Hb至血浆中，这些游离的Hb清除内皮细胞来源的NO速度比红细胞内的Hb快600-1000倍，从而引起NO内稳态的改变。溶血时除了释放Hb，RBC还将精氨酸酶释放到血浆中，进一步破坏了精氨酸的代谢和NO的产生。因此，溶血可致内皮细胞功能障碍，血管收缩性增强，铁离子增加以及全身和肺动脉压升高[18-19, 25,33]。输入储存时间较长的RBC时可考虑给予80ppm iNO和静脉注射结合珠蛋白。前者可有效减轻或预防输血所致的全身和肺动脉高压以及多器官损伤，而后者则显示结合珠蛋白迅速且不可逆地结合游离Hb形成结合珠蛋白-血红蛋白复合物而被网状内皮系统清除[18, 25,33, 38]。

可输送氧的红细胞替代物（HBOC）因含血色素而可迅速清除患者体内内源性NO，与输入储存时间较长的RBC而致全身血管收缩的结果相似，从而降低了患者体内可松弛血管平滑肌的NO浓度。为了减少细胞外Hb清除NO，输入RBC替代物同时外源性吸入NO可与之结合而有效预防血管收缩，避免全身和肺高压，用这种治疗方法也未发现明显高铁血红蛋白浓度升高[25,33]。

现已证明，缺氧时红细胞脱氧-Hb可将亚硝酸盐还原成NO。Hb作为亚硝酸盐还原酶使脱氧-Hb-亚硝酸盐反应生成NO，导致缺氧性血管舒张[18-19]。RBC内的NO通过调节RBC可变形性以及O_2携带-释放功能而影响O_2的释放，这在血管内稳中发挥重要作用[38-39]。

3. iNO与冠状病毒感染

严重急性呼吸系统综合症（SARS）于2002年秋季在中国广东省首次发现。十七年后，2019年12月在中国武汉报道了首例新型冠状病毒（SARS-CoV-2）引起肺炎病例[20-21, 40-41]。冠状病毒的爆发以及严重ARDS是导致死亡的主要原因，因此需要寻找有效的抗病毒药物来治疗该病毒感染。但是，在有效疫苗问世前SARS-CoV和SARS-CoV-2的治疗很大程度上还是凭经验进行，尚未建立有效的特定药物。

生理条件下iNOS生成的NO具有抗增殖和抗炎作用。而在病理状态下，由于感染期间iNOS的刺激上调，巨噬细胞会针对病毒生成并分泌大量NO[20, 26, 30]。据报道，已知NO除了对病毒的毒性作用外，还可抑制冠状病毒蛋白和RNA的合成以及病毒的复制[20-21,40]。

2004年时就已证明iNO在SARS-CoV患者肺部并发症治疗中有重要辅助作用。iNO抑制SARS病毒合成和复制，降低肺动脉高压，改善患者严重缺氧并缩短了呼吸支持时间[20,40]。2020年，有几组临床研究使用iNO辅助治疗针对需O_2但尚未气管插管的COVID-19感染患者。其目的在于探索iNO是否参与病原体的免疫反应，防止病毒复制，预防ARDS患者疾病继续恶化[22, 42-43]。

4. iNO和麻醉

愈来愈多的肺动脉高压患者吸入NO治疗，他们中一些人因各种原因需进行外科手术。肺动脉高压或急性低氧血症伴有血流动力学不稳定所致疾病的复杂性和麻醉，手术的风险，给麻醉医生带来了极大挑战。当常规治疗方法无效时，iNO作为救援疗法使用。由于这些病人围术期的发病率和死亡率增加，麻醉医生对iNO的熟悉和理解对于确保其安全麻醉至关重要。

在笔者医院，呼吸治疗师与吸入NO的患者一起进入手术室，麻醉和手术时呼吸治疗师根据患者的临床状况持续监测和调节iNO剂量。吸入iNO的患者切忌突然停药，因为这会导致反跳性肺高压恶化和急性低氧血症。iNO通过气螺中的混合阀将加压的NO和氧气混合后临床使用，当iNO使用数天后，应根据血氧分压值（PaO2）逐渐降低iNO剂量。氧饱合度和血流动力学不稳定的患者，iNO 10-20 ppm基本认为安全。随着氧饱合度的改善，吸入气中的氧浓度（FiO2）降低至≤50%。随后iNO通常以每1到2小时减少5ppm的量从20ppm降低到5ppm。再以每1到2个小时减量1ppm。将iNO从1ppm至停用时需十分谨慎。麻醉医生应密切监测患者的血压，呼吸参数和氧饱合度，避免低氧，高碳血症，酸中毒和体温过低酸中毒和体温过低所致的肺血管阻力增加和右心失代偿和右心衰。

最后需强调的是，尽管大家已知iNO可降低肺动脉高压和肺水肿，改善右心室功能和全身氧饱合度，但对患者机械通气，住院时间长短，围手术期发病率和死亡率无显著影响[13, 44]。

Bibliography

1. Koshland Jr. DE. The molecule of the year. Science. 1992; V.258 (5090):1861.
2. Joseph Priestley. Observations on different kinds of air. Phil. Trans. 1772; 62, 147–264.
3. Brunton TL. On the use of nitrite of amyl in angina pectoris. Lancet. 1867; 2:97.
4. Ignarro L, J. Nitric oxide is not just blowing in the wind. British J Pharm. 2019; 176: 131-134.
5. Zapol WM. Nitric oxide story. Anesthesiology 2019; 130: 435-440.
6. Frostell C, Fratacci MD, Wain JC, Jones R, et al. Inhaled Nitric Oxide. A Selective Pulmonary Vasodilator Reversing Hypoxic Pulmonary Vasoconstriction. Circulation 1991; 83:2038-2047.
7. Davis MD, Donn SM, Ward RM. Administration of inhaled pulmonary vasodilators to the mechanically ventilated neonatal patient. Pediatr Drugs. 2017; 19: 183-192.
8. Kuch BA, Saville AL, De-Toledo JS, Venkataraman ST. Inhaled pulmonary vasodilators: Are there indications within the pediatric ICU? Respir Care. 2017; 62(6): 678-698.
9. Yu BG, Ichinose F, Bloch DB, et al. Inhaled Nitric Oxide. British J Pharm. 2019; 176: 246-255.
10. Yu BG, Zadek F, Fischbach A, et al. Intra-tracheal injection of nitric oxide, generated from air by pulsed electrical discharge, for the treatment of pulmonary hypertension in awake ambulatory lambs. Nitric Oxide 2020; 97: 11-15.
11. Dani C, Bertini G. Inhaled Nitric Oxide for the Treatment of Preterm Infants with Respiratory Distress Syndrome. Neonatology 2008; 94:87-95.
12. Alessandri F, Pugliese F, Ranieri VM. The role of rescue therapies in the treatment of severe ARDS. Resir Care 2018; 63(1): 92-101.
13. Karam O, Gebistorf F, Wetterslev J, Afshari A. The effect of inhaled nitric oxide in acute respiratory distress syndrome in children and adults: a Cochrane systematic review with trial sequential analysis. Anesthesioogy 2017; 72: 106-117.
14. Kracuski RA, Warner JJ, Wang A, et al. Inhaled nitric oxide selectively dilates pulmonary vasculature in adult patients with pulmonary hypertension, Irrespectively of etiology. J Am Coll Cardil 2000; 36: 2201-2211.
15. Sharma A, Obiagwu C, Mezue K, et al. Role of vasodilator testing in pulmonary hypertension. Progress in cardiocascular diseases. 2016; 58: 425-433.
16. Hill NS, Preston IR, Roberts KE. Inhaled therapies for pulmonary hypertension. Resp Care. 2015; 60(6): 794-805.
17. Rao V, Ghadimi K, Keeyapaj W, et al. Inhaled nitric oxide (iNO) and inhaled epoprostenol (iPGI2) use in cardiothoracic surgical patients: is there sufficient evidence for evidence-based recommendations? J. Cardiothoracic and Vascular anesthesia. 2018; 32: 1452-1457.
18. Baron DM, Lei C, Berra L. Old, older, the oldest: red blood cells storage and the potential harm of using older blood cell concentrates. The Current Opinion 2020; 33 (2): 234-239.
19. Gladwin MT. ADVANCES IN EXPERIMENTAL MEDICINE AND BIOLOGY. Volume 588. Role of the Red Blood Cell in Nitric Oxide Homeostasis and Hypoxic Vasodilation. Hypoxia and Exercise. 2007; pp: 189-205.
20. Åkerström S, Mousavi-Jazi M, Klingström J, et al. Nitric Oxide Inhibits the Replication Cycle of Severe Acute Respiratory Syndrome Coronavirus. J Virol. 2005; 79(3): 1966–1969.
21. Akaike T, Maeda H. Nitric oxide and virus infection. Immunology 2000; 101: 300-308.
22. Kobayashi J, Mutata I: Nitric oxide inhalation as an interventional rescue therapy for COVId-19-induced acute respiratory distress syndrome. Annals of Intensive Care. 2020; 10:61.
23. Stuehr DJ, Haque MM. Nitric oxide synthase enzymology in the 20 years after the Nobel Prize. British J. Pharm 2019; 176: 17 7-188.
24. Garcia V, Sessa WC. Endothelial NOS: perspective and recent developments. British J. Pharm 2019; 176: 189-196.

25. Yu BL, Ichinose F, Bloch DB, at el. Inhaled nitric oxide. British J. Pharm 2019; 176: 146-255.
26. Picón-Pagès P, Garcia-Buendia J, Muñoz FJ. Functions and dysfunctions of nitric oxide in brain. BBA - Molecular Basis of Disease. 2019; 1865:1949–1967.
27. Lundberg JO, Weitzberg E. NO Generation from Nitrite and Its Role in Vascular Control. Arteriosclerosis, Thrombosis, and Vascular Biology. 2005; 25(5): 915-922.
28. Rhoades RA, Tanner GA. Medical physiology 2nd edition. 2003.
29. Susswein A, Katzoff A, Miller N, et al. Nitric oxide and memory. Neuroscientist. 2004; 10(2):153–162.
30. Schairer DO, Chouake JS, Nosanchuk JD, et al. The potential of nitric oxide releasing therapies as antimicrobial agents. Virulence 2012; 3(3): 271–279.
31. Weinberger B, Laskin DL, Heck DE, Laskin JD. The Toxicology of Inhaled Nitric Oxide. Toxicological Sciences. 2001; 59 (1): 5-16.
32. Wallace JL. Nitric oxide in the gastrointestinal tract: opportunities for drug development. British J. Pharm 2019; 176: 147-154.
33. Yu BL, Bloch KD, Zapol WM. Hemoglobin Based Red Blood Cell Substitutes and Nitric Oxide. Trends Cardiovasc Med. 2009; 19(3): 103–107.
34. Siegel MD. Acute respiratory distress syndrome: Epidemiology, pathophysiology, pathology, and etiology in adults. UpTo-Date. 2020; 5.
35. Abman SH, Kinsella JP, Schaffer MS, Wilkening RB. Inhaled Nitric Oxide in the Management of a Premature Newborn With Severe Respiratory Distress and Pulmonary Hypertension. Pediatrics. 1993; 92: 606-609.
36. Walsh BK, Rettig JS. Implementation of an inhaled nitric oxide protocol: A paradox or the perfect pair? Respiratory Care. 2015; 60(5): 760-761.
37. Lotti GA, Olivei MC, Palo A, et al. Acute effects of inhaled nitric oxide in adult respiratory distress syndrome. Eur Resir J 1998; 12: 1164-1171.
38. Helms CC, Gladwin MT, Kim-Shapiro DB. Erythrocytes and Vascular Function: Oxygen and Nitric Oxide. Front. Physiol. 2018; https://doi.org/10.3389/fphys.2018.00125.
39. Zhao YJ, Wang X, Noviana M, Hou M. Nitric oxide in red blood cell adaptation to hypoxia. Acta Biochim Biophys Sin. 2018; 50(7): 621–634.
40. Keyaerts E, Vijgen L, Chen LN. Inhibition of SARS-coronavirus infection in vitro by S-nitroso-N-acetylpenicillamine, a nitric oxide donor compound. International Journal of Infectious Diseases. 2004; 8: 223—226.
41. Huang CL, Wang YM, Li XW, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet. 2020; 395: 497-506.
42. Andreou A, Trantza S, Filippou D, et al. COVID-19: The Potential Role of Copper and N-acetylcysteine (NAC) in a Combination of Candidate Antiviral Treatments Against SARS-CoV-2. In vivo 2020, 34: 1567-1588.
43. Wu RY, Wang LJ, Kuo HD et al. An update on current therapeutic drugs treating COVID 19. Cur. Pharm. Rep. 2020; 11: 1-15.
44. E Robin, E Haddad, B Vallet. Inhaled Nitric Oxide in the Perioperative Period and Recovery. Ann Fr. Anesth Reanim. 2002; 21(7):581-90.

围术期临床脆弱状态评级（CLINICAL FRAILTY SCALE）的应用

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老年人生理脆弱（Physical frailty）是临床上普遍可以识别的状态，由此增加了不良事件的发生率比如失能、摔倒、住院和死亡等。脆弱定义为与衰老相关的因多方面生理系统机能下降造成机体的应激力和抵抗力减弱的一组生物医学综合征[1]。临床医生和研究人员需要制定一套标准方法来精准一致地辨别那些最脆弱的患者以便更好地管理他们的医疗健康。至今已有几百个研究表明脆弱状态也是评估围术期患者危险的有用手段，研究证实术前评估脆弱性降低了术后并发症、减轻了患者苦痛和改善了生活品质[2,3]。目前临床脆弱状态评级（Clinical Frailty Scale，CFS）常做为一种分级诊疗工具用于制定重要的临床决策[4]，例如COVID-19治疗管理中稀有医疗资源的调配，因此，正确使用这个评级十分重要[5]。

Fried, Tangen, Walston 等最早于2001年的心血管健康研究中提出脆弱表型（Frailty Phenotype，FP）的概念[6]，之后2006年 Bandeen-Roche 等人在进行妇女健康和衰老研究时进一步验证FP的观念[7]。使用FP工具时通过衡量五种表型指标来定义脆弱：

- 非有意的减重（肌肉容积减少）
- 自己报告的劳累耗竭
- 运动水平和耗能低下
- 手握力减弱
- 行走步履缓慢

测定FP除了问答题还要量体重、小耗国、握力仪测量手握力值、记录起立行走15英尺所需时间和填表，大约花费15分钟。

相比之下，2005年由加拿大新斯科舍省 Halifax 市的老年科研究人员率先提出CFS，现已用于20多个国家的临床常规和研究中[8]。通过对运动体能、认知功能、成人看护依赖性、营养状态和心理健康的综合判断和示意图可以在45秒内完成评分（图1）。

一、为什么评估脆弱状态？

随着世界人口日渐老化，老人住院的数量与日俱增。事实上75岁以上老人因急症入院数量已经显著增加，管理这些入院病人对医疗系统来讲已变得越来越困难[9]。其中脆弱的老人在急诊入院的患者中占有很大比例，与不脆弱的体健老人相比，脆弱的老人再次入院率、住院时间和死亡率都更高[10]。早期识别这些老人有助于减轻一些不好的预后，也会减少医疗系统的负担。特别是新冠病毒大流行病肆虐期间，一些病重老人需要住进ICU抢救，重症监护病房与年龄相关的负担明显存在；意大利第一批18,366名COVID-19死者中83%是70岁以上的老人，在65岁以上危重患者中28天后死亡的危险性超过50%[11]。国际上各地的反应迥异，但似乎在CFS 评分5-6以上就不再考虑收入ICU这方面达成共识[5]。

在针对应激反应方面，评定是否脆弱造成康复的差异上尤其重要。脆弱的患者即使是对很轻微的疾病也更易经历更严重的反应，随而每况愈下，导致需要更长的康复时间。这种应激抵抗力的减弱会继发造成临时或永久的丧失独立生活能力[12]。

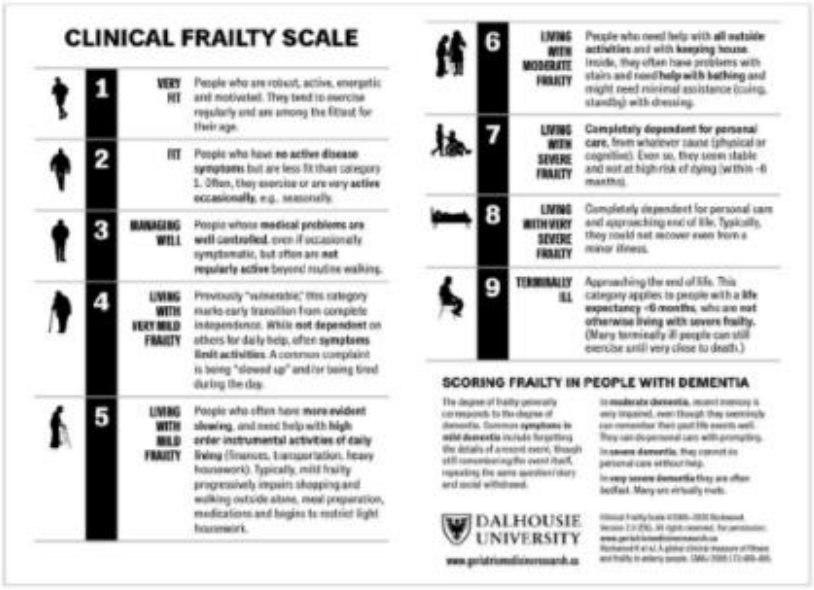

图1. 临床脆弱评级（第二版）

二、为什么在术前评估脆弱状态

老年人比其他年龄组的手术率更高。约40%的手术老人伴有脆弱的生活[13]。我们已知脆弱的老人不耐受各种压力，而外科手术无疑会诱发相当大的生理压力。所以，术前就脆弱者术后不良反应的危险性增加[14,15]。这些危险性包括但不限于以下几方面：

- 死亡
- 严重术后并发症
- 住院时间延长
- 出院后进护理之家或养老院而非回家
- 患者主述术后谵妄、认知障碍和新的失能[16]
- 增加医疗资源的占用和医疗支出

重要的是研究发现脆弱状态可以准确预计这些危险，甚至比传统的围术期危险分级的ASA级别更

有优势。由于脆弱评估的是多方面的功能，术前可以有计划的对其中一项或几项进行改善。锻炼、营养、药物治疗和社区干预都有证据表明可以减轻个体的脆弱表现[17]。

如果我们术前能够常规地准确地识别脆弱，就可以根据个体的情况和需要在术前使患者达到最佳状态，并且策划出院后的交接医疗护理。这样会对患者及家属的围术期体验、医疗预后、医护协调和医疗健康支出都带来积极的正面影响。

脆弱和老化

认清脆弱和变老不是同义词，也不是老化的必然结果。由于永久或暂时的情况，有非常活跃体健的80岁老者，也有脆弱多病的60岁患者。然而，变为脆弱的危险性确实与年龄增加相关。

脆弱和多重并发症

脆弱和多重并发症在老年医学中是显著不同的概念，尽管两者是密切相关的。其中一方可以预计另一方的发生。脆弱经常影响身体多个系统，包括肌肉骨骼、神经、和免疫等系统，由此导致个体更易遭受多重并发症。相反，多重并发症可以引发个体储备机能的加速丧失，从而增加了脆弱的危险性。

脆弱涉及了生物、社会和认知因素等相互交织的复杂体系，负面影响个体独立完成每日生活的能力。脆弱常常在外表上表现为降低了活动力、体重减轻、肌肉强度减低、能量水平变低和日常活动减少。也包括其他特征像需要帮助基本日常生活起居、家务劳动、爬楼困难和感觉“越来越慢”[18]。

综上所述，目前已经认识到对脆弱老年人的医疗关护是改进围术期医疗质量和效率的一个关键靶点。

三、什么是CFS?

临床脆弱分级【The Clinical Frailty Scale (CFS) 】是依据《加拿大健康和老化脆弱指数研究》而创建的面向临床的脆弱分级。在评估患者后，临床医生或培训人员，能够依据图形和简单的描述进行脆弱程度定级(除了从整体评估已经肯定的部分之外)。还有CFS是基于移动力、能量、体力活动和功能区域的临床评估，是总体上有九点的脆弱评级。这是一个极快又容易的估计个体脆弱的方法，与其他更复杂的工具相比省时简单同样可以提供相似的预估信息。

当CFS用于急病或入院评估时，建议采用患者生病两周前的状态而不用发病当时的状态。

如何决定个体的CFS分数？有三个至关重要的因素：

- 总体健健水平：存在或缺乏任何活跃疾病症状（例如，控制很好的糖尿病对脆弱的影响远小于有各种像神经、眼睛或心脏并发症的糖尿病）
- 日常活动中依赖他人的水平
- 认知状态

个体的CFS分数可以从多个渠道获知，包括但不限于：既往患病史、服用药物、社会活动史、现病史、体力失能或受限、合并症、有正式和/或非正式支持的家属或看护人、移动力状态和使用助行

器以及认知状态[19]。评估时要保障仔细询问调查，不要猜测或假设。注意评估脆弱时要牢记外表可以很有欺骗性！

一定要暂促提问获取更多信息。比如，如果患者仍在就业，就去发现他们每天的工作是什么情况。是否整天站着或走动或坐在办公桌前？是否干体力活像抬重物、蹲着等？如果患者讲每周锻炼，就去发现他们的运动习惯。他们是轻松的散步还是做更激烈的运动？对患者了解的越全面，越能更好的给CFS打正确分数。

临床脆弱评级(CFS)第二版（加拿大Dalhousie 大学，www.geriatricmedicineresearch.ca）[5]

非常体健（VERY FIT）：百折不挠、充满活力、精力旺盛和主动自觉的人群。他们趋向于规律的锻炼而且是同龄人中最矫健的个体。

体健（FIT）：目前没有疾病症状但不如第一级矫健的人群。他们经常锻炼或偶尔充满活力，比如做季节性的运动。

维持很好（MANAGING WELL）：有病但控制很好的人群，即便偶尔有症状。经常是除了常规的走路外没有规律的活动。

极轻度脆弱的生活（LIVING WITH VERY MILD FRAILTY）：有“虚弱易病”的过去史，这级标志着从完全独立自主的生活开始了早期的转化。虽然还没有每日依赖他人的帮助，但常常是临床症状限制了各种活动。一个常见的主诉是一天中“变慢了”和/或 “ 感到疲惫”。

轻度脆弱的生活（LIVING WITH MILD FRAILTY）：经常有更多变慢症状的人群，而且日常生活中在高度执行操作活动上（财务管理、交通出行、重体力家务劳动）需要帮助。典型的是轻度脆弱逐渐进展为影响购物和独立户外走路、做饭、服药和开始限制轻体力家务劳动。

中度脆弱的生活（LIVING WITH MODERATE FRAILTY）：所有户外活动和室内活动需要帮助的人群。在室内，他们常常上楼梯困难、需要协助洗浴以及穿衣时需要少许帮助（提示、旁边等候）。

重度脆弱的生活（LIVING WITH SEVERE FRAILTY）：无论从哪个方面（体力或认知上）个人生活完全依赖别人帮助的人群；即使如此，他们似乎平稳没有死亡（六个月之内）的高危险性。

极重度脆弱的生活（LIVING WITH VERY SEVERE FRAILTY）：个人生活完全依赖他人并接近生命终点的人群。典型的是即使发生轻微疾病他们也不再能够康复。

临终疾病（TERMINALLY ILL）：临终人群。这级指的是预期六个月内死亡，即使不死亡也是重度脆弱活着的那些人。(许多临终患者直到非常接近死亡之前仍然能够锻炼。)

1. 附：痴呆患者的脆弱评级

脆弱程度一般与痴呆程度相应。轻度痴呆的常见症状包括忘记最近事件的细节，尽管可以回忆事件本身，重复同一问题、故事并退出社交。

中度痴呆患者严重丧失近期记忆，尽管似乎能很好的记忆远期事件。督促下个人生活能自理。重度痴呆患者没有他人帮助时不能自理个人生活。而极重度痴呆患者常年卧床，很多人基本无语。

四、评级者的偏差

使用CFS评估脆弱时，最佳是采用九点分级为患者定级。与任何用人为裁判的任务一样，一定程度的偏差会影响你的决定。对同等情形不同的评级者打出不同分就会产生评级者偏差。造成评级者偏差的最常见的因素有[20]：

1）对如何恰当的应用有疑问的级别存在不同理解

2）每个评级者对被评级患者的脆弱程度相信度不同

采用CFS时了解几种已知的评级者偏差的类型有助于避免这些偏差。共有四种常见的评级者偏差会导致评级者出错：

1. 怜悯效应：定级时有更宽松的倾向。这经常是评级者个性的结果，他们对评定对象有感情，或整体上他们对人类隐含有独特的见解。这种偏差能造成定级过低。

如何避免怜悯效应？保持开放心态，并且记住你不是给予评估对象的个人判断，注重点在于客观地衡量病人的情况，这样可能减少在评级中的怜悯效应[21]。

2. 趋中效应：评级者在定级时有折中向中间级别靠拢的倾向。评级者趋向于避免两级分数从而导致定级过高或过低。

如何避免趋中效应？理解使用的CFS分级（和评级时患者的基础情况）是避免这一效应的最重要的方法。不要感觉如果采用了最高或最低级就做错了什么也很重要。如果你认为评高级或低级是有理由的，那么就可以接受这个定级。

3. 空洞效应：评级者对评估对象的总体印象程度能够影响他们特定的评级。比如，外表显得健康的老人如果没有进一步询问可能定级过低。反之，外表比实际年龄大的人如果没有进一步提问可能定级过高。

如何避免空洞效应？提问是避免空洞效应的关键。要保证你的定级不是仅基于你的第一印象，而是基于全面评估后的结果，包括与被审查对象相关的专门针对脆弱性的问题。

4. 初始效应：在顺序上对开始表现的信息比后来表现的信息记忆更好的趋势。比如，如果某人先描述了身体维持好但进一步询问后发现日常生活料理需要他人帮助，初始效应能造成评级者定级过低，反之亦然。

如何避免初始效应？可以采取几条策略。第一，最后定级时要有意识的参照所有已知信息。第二，对每一个评估考虑使用标准手段；这样做即使最开始的问题给你强烈印象，每次评估时你会根据同类型新的信息更新印象[22]。

3) 反应偏差

在使用CFS评定脆弱的过程中，也会遇到“反应偏差”。不管有意或无意，当回答问题的答案与

答题者的真诚态度、信仰或行为不一致时会出现反应偏差。完成CFS评估时最常见的就是回忆偏差。这指的是当患者或看护人报告不准确的信息，无论是无意间未查出认知障碍还是因为以下原因有意所为：

1）患者或看护人对脆弱的概念有误，他们将依赖他人照顾看成是个弱点；

2）出于文化上对年长者的尊重，患者子女（看护人）不愿与患者本人报告的高于实际的功能相悖；

3）有时看护人因为过劳耗竭而过度报告脆弱程度，等。

如何避免回忆偏差？总体讲避免回忆偏差极为困难，你可以以通过强调患者被评估的重要性来尽量减少偏差为目标，集中在当时的身体、情绪和认知健康状态[23]。不要提问需要让患者回忆很久以前的情况一类的问题，这样会导致不准确的反应。再者，向患者和他们的看护人保证他们对问题的回答不会影响患者的就医和造成任何负面干预，这点永远都很重要，非但不会贻误医疗，决定CFS的分数将有助于临床团队优化患者的治疗计划。

五、有关评分的最后暗示和今后的进步

在临床脆弱状态评分的每一级里，个人的特殊性都有差异。大约80%多的人会符合所定一级的描述。如果他们符合其中两级的程度相等，那么常规护理上最好按级别更高也就是更依赖他人的那一级打分。有时我们看到人们特殊情况下依赖某单项工具性日常生活（例如，依赖他们信任的人办理银行业务因为受托人离银行办事处近或患者不熟悉自动取款机操作），这时评级的判断上可能有些变数，特别取决于评级者和被评者是否可以从容放心的讨论此类问题。

另外还要强调的一点是：发生COVID-19感染时脆弱状态评级与常规老年医学关护的评级是不同的。平时老年医学的脆弱评级的目标既是通过共享的语言使沟通更流畅，也是制定医护计划的基础。后者需要覆盖两方面的距离，一方面是目前的功能、认知、移动性和社交关系（尤其是与主要的看护者之间）水平，另一方面是出现急性病时上述各项是如何变化的。这是非常重要的区别，需要评级者具备相当的技巧进行定级、谈判、评估和在住院过程中调整。

今后希望至少在围术期广泛使用CFS后可以带来多方面的益处。近年来大力倡导的术后加强康复计划（ERAS）和围术期脑健康启动项目（Brain Health Initiative）包括重视评估CFS对术后谵妄和长期认知功能障碍的影响、对术后并发症和死亡的影响及总体康复结局的影响[24,25]，无疑会进一步提高围术期安全和麻醉质量。

参考文献：

1. Daniel E Hall et al. Association of a Frailty Screening Initiative With Postoperative Survival at 30, 180, and 365 Days. JAMA Surg 2017 Mar 1;152(3):233-240.
2. Sarah A. Vermillion et al. Modified frailty index predicts postoperative outcomes in older gastrointestinal cancer patients. J Surg Oncol 2017 June; 115(8): 997-1003
3. Robert P Runner et al. Modified Frailty Index Is an Effective Risk Assessment Tool in Primary Total Knee Arthroplasty. J Arthroplasty 2017 Sept; 32(9): S177-82
4. World Health Organization. Ethical considerations in developing a public health response to pandemic influenza. Geneva, Switzerland: WHO; 2007. https://www.who.int/csr/resources/publications/WHO_CDS_EPR_GIP_2007_2c.pdf
5. Kenneth Rockwood and Olga Theou. Using the Clinical Frailty Scale in Allocating Scarce Health Care Resources. Canadian J Geriatrics. 2020(9): 210-15

6. L P Fried et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci .2001 Mar;56(3):M146-56.
7. C. Fisher et al. Predicting intensive care and hospital outcome with the Dalhousie Clinical Frailty Scale: a pilot assessment. Anaesth Intensive Care 2015, 43(3): 361-8.
8. Oo MT et al. Understanding Clinical Importance of Frailty and Designing a Frailty Assessment Tool in Acute Hospitals. J Gerontol Geriat Res. 2014;3(4).
9. Conroy SP et al. A systematic review of comprehensive geriatric assessment to improve outcomes for frail older people being rapidly discharged from acute hospital: 'interface geriatrics'. Age Ageing. 2011;40(4):436-43.
10. Rockwood K, Howlett SE. Age-related deficit accumulation and the diseases of ageing. Mech Ageing Dev. 2019; 180:107–16.
11. Boccardi V et al. COVID-19: a geriatric emergency. Geriatrics. (Basel). 2020;5(2):E24.
12. Clegg A et al. Frailty in elderly people. Lancet. 2013; 381(9868):752-62.
13. Turrentine FE et al. Surgical risk factors, morbidity, and mortality in elderly patients. J Am Coll Surg. 2006;203(6):865–77.
14. Oresanya LB etal. Preoperative assessment of the older patient: a narrative review. JAMA. 2014;311(20):2110–20.
15. Melsaac DI et al. Frailty as a Predictor of Death or New Disability After Surgery: A Prospective Cohort Study. Ann Surg. 2020;271(2):283-289.
16. Susano MJ et al. Brief Preoperative Screening for Frailty and Cognitive Impairment Predicts Delirium after Spine Surgery. Anesthesiology 2020, 133(4):
17. Partridge JSL et al. Frailty in the older surgical patient: a review. Age Ageing. 2012;41(2):142–7.
18. Anaya DA et al. Summary of the Panel Session at the 38th Annual Surgical Symposium of the Association of VA Surgeons: What Is the Big Deal About Frailty? JAMA Surg. 2014;149(11):1191-1197.
19. Davies J et al. Inter-Rater Reliability of the Retrospectively Assigned Clinical Frailty Scale Score in a Geriatric Outreach Population. Can Geriatr J. 2018;21(1): 1-5.
20. Hoyt WT. Rater bias in psychological research: When is it a problem and what can we do about it?. Psychological methods. 2000 Mar;5(1):64.
21. Cheng KHC et al. Leniency Bias in Performance Ratings: The Big-Five Correlates. Front Psychol. 2017;8:521.
22. Cook DA et al. Effect of Rater Training on Reliability and Accuracy of Mini-CEX Scores: A Randomized, Controlled Trial. J Gen Intern Med. 2019;24(1):74-79.
23. Pannucci CJ, Wilkins EG. Identifying and avoiding bias in research. Plast Reconstr Surg. 2010;126(2):619–625.
24. Nakano M et al. Functional Outcomes of Frail Patients After Cardiac Surgery: An Observational Study. Anesth Analg 2020;130(6):1534-1544
25. Goldberg TE et al. Association of Delirium With Long-term Cognitive Decline: A Meta-analysis. JAMA Neurol 2020; Jul 13; e202273. doi: 10.1001/jamaneurol.2020.2273. Online ahead of print.

国际麻醉

《手术安全核查制度》实施10年，我们还有哪些问题？

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1 前言

世界卫生组织（World Health Organization. WHO）在2008年6月向全球推出了《手术安全核查表》[1]。同年，核查表被翻译成中文并全文刊登于中国麻醉医师协会《新闻通讯》(2008年第12期)，并启动了在北京协和医院的试运行[2]。手术安全核查很快得到了国家层面的重视，当时的国家卫生部在2010年3月17日正式发布文件，要求在全国推广实施《手术安全核查制度》。迄今为止，“WHO手术安全核查”引进中国已经10年，国家卫生行政主管部门已将其作为保障医疗安全的一项核心制度，要求强制执行。然而，强制使用并不等于正确使用，我们曾经在5年前进行过单中心的手术安全核查执行状况调查，发现核查表的使用存在一些问题，诸如核查不完整、一带而过、回答随意和关键医师未到场核查等，有的甚至不实施核查，而仅仅是完成了核查表的填写[3]。因此，我们近期通过问卷调查的形式，调查了手术安全核查在国内执行10周年的现状，反馈的结果有喜有忧。

2 核查制度实施10年调查所揭示的关键数据

2.1 核查实施状况[4]

对于麻醉实施前核查，多数医院是常规进行（93%），而且基本是按照核查单上所有项目逐一进行的核对。关于之前一直纠结的外科医师是否参与本次核查的问题，仅有14%的答题者报告其所在医院的外科医生不参与此步骤核查。对于参与核查的外科医生，有超过半数（53%）的答题者选择了“核查外科医生不固定为某一职位医生”，而主刀医生参与核查和一助或管床医生参与核查分别占到11%和18%。

对于手术开始前核查，78%的答题者报告其所在医院是常规进行，但是，按照所有项目逐一核对的百分率降低至52%，对于关键问题的专业交流，无论是对麻醉医生还是外科医生，常规陈述者均不到20%。

对于病人离室前核查，64%的答题者报告其所在医院是常规进行，但是，按照所有项目逐一核对的百分率继续降低至44%。

2.2 核查的整体评价和热点问题反馈[5]

尽管超过半数的答题者认为整个医疗团队进行核查时的态度是“认真的”，但是依然有不少认为是“匆忙核对”，甚至是“对患者情况不够了解，随意回答”。

在多数答题者所在的医院，麻醉医生/麻醉护士是目前所在医院核对的主导者（或者协调者），而1/3选择了手术室护士，只有5%答题者报告称外科医生是他们医院核对的主导者（或者协调者）。超过80%的答题者认为麻醉实施前核查（即第一次核对），外科医生应该参与，因为最了解病人。因此，为了更好的执行手术安全核查，更加合适的核对主导者或（协调者）在答题者心目中的排序是：麻醉医生/麻醉护士，外科医生和手术室护士。

对于执行“手术安全核查”所面临的障碍，反馈的排序依次为：“太麻烦：费时、费力”、“不了解核对表”、“核查表不适合这类手术”、“核查意义不大”等。尽管核对表面临一些问题或者争议，但是在问及“如果您或您的家人将要接受外科手术，您希望您的手术团队执行“手术安全核查”吗？”，几乎所有的答题者（98%）都希望执行核查。此外，几乎所有的答题者（94%）都认为践行《手术安全核查》可以减少手术并发症，提高患者麻醉手术安全。

3 现存的问题及解决的思路

3.1外科医师是否需要参与第一次核查？

外科医师参与第1步核查的困难在于其难以就位，这就必然增加核查的阻力，调查的数据也揭示了这一尴尬的现状。国家颁布的文件明确要求在3个时段，由三方医务人员来共同核查[1]。而事实上，在WHO核查表使用手册里面，并没有强调初次核查时外科医师必须参与。WHO认为，麻醉诱导前的初次核查，核查人员（一般是巡回护士）要与麻醉医师和患者（如果可能的话）一起完成相关内容，在此阶段，外科医师最好在场。因为他更了解手术期间可能出现的失血量等复杂因素。但是，外科医师是否在场并不影响此部分内容的核查[7]。我们持与WHO类似观点，如果患者不能交流，如存在意识不清或者患者为婴幼儿，管床的外科医生必须参与本次核对。

3.2《手术安全核查表》只是为避免患者及手术错误吗？

错误的患者、错误的手术和错误的手术部位都是不可饶恕性的红线事件，是绝对不应该发生的错误，是非常严重的手术安全问题。核查表的确就此问题分别在第一次和第二次核对做了重复的强调。一些医务人员误认为这就是核查表的全部作用。在实际核查过程中，仅认真核查了患者身份、手术方式和手术部位，对核查表上的其他条目，特别是第二次核查中关于手术与麻醉的风险交流，则一带而过[3]。

由于专业角度不同，各专业之间缺乏通畅的交流渠道。虽然麻醉医师在术前按照规定访视患者，进行了风险评估，但可能对手术主要步骤了解不够、对手术风险估计不足、准备不充分；而外科医师则有可能一味要求麻醉医师提供更加利于手术的条件而忽略患者合并的心肺疾病。第二次核查的核心目的是在手术开始之前，对患者手术相关的专业问题进行最后一遍的正式交流。通过交流，麻醉医师在确保患者安全同时，为手术创造有利条件；而手术医师在顺利完成手术的同时，兼顾到手术对患者全身状况的影响[10]。因此，从这个角度来说，实施安全核查不仅有助于降低围术期并发症发生率和死亡率，也有助于加强团队协作，构建安全文化。

3.3谁是实施核查的组织者？

关于由谁来组织实施核查的问题，WHO在核查表使用手册里面明确要求，首先要有明确的核查组织者，即协调员，并建议由手术室的巡回护士担任协调员，但也可以由参与手术的任何一名临床医师来担任[7]。在我国，考虑到医疗制度的执行力，卫生行政部门直接将手术医师或麻醉医师定为实施核查的组织者，并写进了国家颁布的医疗文件[6]。调查显示，在我国的实际医疗实践中，核查的现行主导者（或者协调者）在多数医院是麻醉医生/麻醉护士，但是在问及谁是理想的核对主导者（或者协调者）时，外科医生则上升到40%。该项数据说明，外科医生应该在手术安全核查过程中承担更多的责任，这也有利于该项制度的执行。

3.4实施核查的阻力在哪里?

在问及执行核查的主要困难时，排序靠前因素之中：核对表“太麻烦、费时、费力”和“不适合这类手术”应该引起患者安全管理者的重视。这两个因素有可能包括主观的认识误区，也可能反应了核查表自身的现实问题。手术安全核查表在我国应用之初便被赋予了极强的行政色彩，被认为是不可更改的。事实上，同一张内容的核查表如果能够用于复杂的心脏移植手术，其必然不适用于大不相同的剖宫产手术，更不适合在门诊即可实施的无痛人流手术。WHO在核查表的使用手册中明确指出：“各地可根据自身情况对核查表进行适当修订，但是原则和精髓应当予以保留”。由WHO发布的核查表不可能一成不变、一劳永逸地适用于全球所有医院，应该鼓励本土化；对于一些专科性的医学中心，核查表更应该专业化[7]。

根据美国病人安全基金会新闻通讯的近期报道，在2010 年，美国门诊手术安全研究所 (ISOBS) 根据WHO手术安全核查清单制定了门诊手术患者安全核查清单，是专门针对门诊手术室的手术实践进行了定制。到2017年，ISOBS门诊手术核查清单（图 1）被添加至美国医疗保健风险管理科学院 (ASHRM) 的门诊室手术资源手册中，可以到该网站（https://www.ashrm.org/）登录下载[9]。

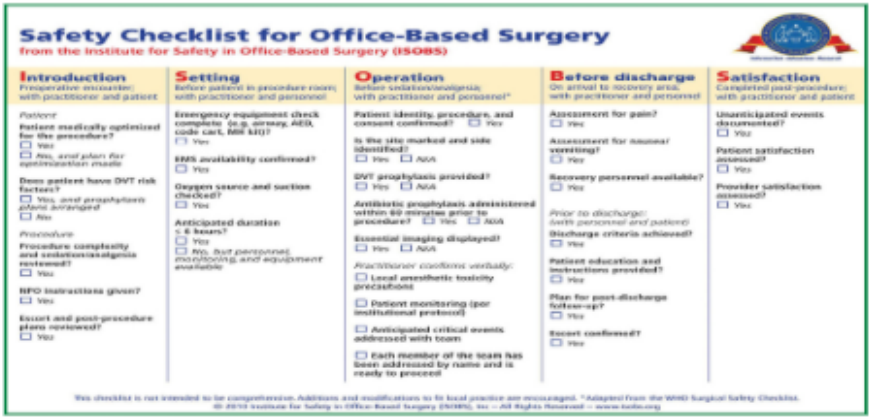

图1：ISOBS门诊手术核查清单

这些优化与简化，不仅符合门诊手术的专业实际需求，也更加便于门诊手术的医务人员去实施核查。因此，提倡各医疗单位根据各自的实际情况改良核查表，使之符合医院的实际，也符合专业的需

杀；一刀切、一成不变的核查表本身就是实施核查的障碍。

此外，还应该加强宣教与培训力度，增加对核查制度的理解，增加核查实施的依从性，去改变核查制度的认识误区。实施核查不仅有助于医务人员关注直接的安全问题，更有助于加强团队协作，构建系统的安全文化。最后，要相信现有的循证医学证据，规范地执行安全核查,从而最终提高围术期安全。

参考文献

1. Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. N Engl J Med. 2009;360: 491-499.
2. 朱斌　黄宇光. 手术安全核对表的实施与应用分析. 中国医院管理杂志，2012年第4期.34-35.
3. 马爽 朱斌 黄宇光 手术安全核对制度在我院实施情况的调查与分析 中国医院管理2013年 第9期 43-44
4. 朱斌，黄宇光，黄建宏 等.“WHO手术安全核查”执行10周年的现状调查研究[J]. 《中华麻醉学杂志》, 2019，39（9）1041-1046
5. Eslahpazir BA, Zhu B, Gao H, et al. Perceptions of the WHO Surgical Safety Checklist When Implemented by the Multidisciplinary OR Team. American Journal of Medical Quality, 2020. Article first published online: March 8, 2020/10/9. DOI:10.1177/1062860620918292
6. 卫生部办公厅关于印发《手术安全核查制度》的通知http://www.nhc.gov.cn/wjw/gfxwj/201304/f95253fa25c14d339ed99ef75f5c2b17.shtml 2019/5/19查
7. WHO Surgical Safety Checklist Implementation. https://www.who.int/patientsafety/topics/safe-sargery/checklist_implementation/en/2019/5/19查
8. 朱斌 实施手术安全核查制度的常见误区与对策. 麻醉安全与质控杂志 2017年1(4):199-201

https://www.apsf.org/article/educating-the-next-generation-a-curriculum-for-providing-safe-anesthesia-in-office-based-surgery/2020/10/9查

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Thoracolumbar Dorsal Ramus Nerve Block Using Continuous Multiorifice Infusion Catheters: A Novel Technique for Postoperative Analgesia After Scoliosis Surgery

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Thoracolumbar Dorsal Ramus Nerve Block Using Continuous Multiorifice Infusion Catheters: A Novel Technique for Postoperative Analgesia After Scoliosis Surgery

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ABSTRACT

Background: This is a brief technical report about a novel regional anesthesia technique in which local anesthetic was deposited around the thoracolumbar dorsal rami nerves via 4 multiorifice pain catheters to obtain analgesia for posterior spinal fusion surgery on scoliosis patients. Scoliosis is the most common deformity of the spine. Currently, most surgeons prefer a dual rod, segmental spinal fixation system that allows multiple anchor points for attachment to the deformed spine. Scoliosis surgery is an extremely painful surgical procedure due to the large incision, surgical trauma to superficial and deep muscles of the back, and the insertion of pedicle screws and metal rods directly into the vertebral column. Postoperative pain management remains very challenging.

Methods: Three patients presented with scoliosis. Intraoperatively, 4 multiorifice catheters were placed lateral to the implanted pedicle screws. Two catheters were placed on each side, and a continuous infusion of 0.2 % ropivacaine was initiated postoperatively to improve the patient's pain control. The catheters remained in place for 48 hours postoperatively and were removed by the surgical team. Gentle traction was applied similar to the way epidural catheters are removed.

Results: All 3 patients reported very low pain scores, low doses of opioid consumption, and satisfaction with their pain control throughout their hospitalization.

Conclusions: Our study results suggest that a thoracolumbar dorsal ramus nerve block using continuous multiorifice infusion catheters significantly improved postoperative comfort and pain and that its implementation into a multimodal analgesic regimen is relatively easy to achieve.

New Technology

Keywords: thoracolumbar dorsal ramus nerve block, multiorifice pain catheters, scoliosis surgery, posterior spinal fusion surgery, postoperative pain management

INTRODUCTION

Approximately 30 000 spine fusions for scoliosis are performed in the United States every year,[1,2] and most of these employ a dual rod, segmental spinal fixation. This technique allows multiple anchor points for correction of the deformed spine. These procedures require long incisions and extensive muscular dissection, with frequent multilevel bone osteotomies. As a result, patients commonly suffer from severe postoperative pain. Currently, postoperative pain management has been based primarily on a multimodal analgesic regimen composed of intravenous opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, and epidural anesthesia.[3] However, epidural anesthesia has significant limitations: including a tendency to cause hypotension, unnecessary blockage on the ventral ramus nerve that can cause significant motor and sensory blocks, limitations on postoperative neurological exam, and patchy and inadequate analgesic effect. We present a novel regional anesthetic technique in which local anesthetic is deposited around the thoracolumbar dorsal ramus nerve (TDRN) via 4 multiorifice pain catheters placed intraoperatively under direct visualization by the surgeon, which avoids many of the limitations encountered with epidurals.

MATERIALS AND METHODS

Three patients with adolescent idiopathic scoliosis (AIS) presented to the hospital for posterior spinal fusion and instrumentation (Table). All 3

Table. Patient characteristics and total narcotic consumption.

	Patient 1	Patient 2	Patient 3
Age, y	16	11	13
Weight, kg	54	60	41.8
Height, cm	161	160	163
Cobb angle preoperative	52°	42° (T4–T11), 54° (T11–L3)	53° (T5–T12), 54° (T12–L4)
Cobb angle postoperative	9°	18° (T4–T11), 15° (T11–L3)	10° (T5–T12), 9° (T12–L4)
Instrumentation length, segments	T3–L4	T4–L4	T4–L4
Total narcotic MMEs, mg postoperative 48 h[a]	20	0	34.5

Abbreviations: MME, morphine milligram equivalent.
[a]Hydromorphone patient-controlled analgesia converted at rate of 1 mg hydromorphone, 5 mg morphine.

patients did not have significant past medical histories other than AIS. Intraoperatively, each patient received general anesthesia with total intravenous anesthesia (propofol and remifentanil infusion) and with a titration of narcotics prior to extubation. For each patient, before wound closure, multiorifice "OnQ" catheters (12.5 cm, ON-Q Pain Relief System©, I-Flow Corporation, Lake Forest, CA) were placed at the discretion of the attending orthopaedic surgeon. The catheters were placed laterally adjacent to the implanted pedicle screws under direct visualization (Figure 1a) to target the TDRNs at multiple vertebral levels. Our goal was to block sensory and motor innervation to the posterior muscles and skin with constant infusion of local anesthetic. We anticipated that 2 multi-orifice catheters placed on each side (4 catheters total) would improve the spread of local anesthetic and the coverage of more vertebral levels, and thus provide efficient analgesia. The catheters were identified as left upper catheter (LUC), left lower catheter (LLC), right upper catheter (RUC), and right lower catheter (RLC). The 2 left-sided catheters (LUC and LLC) were connected by a "Stopcock" and sharing 1 infusion pump. The 2 right-sided catheters (RUC and RLC) were similarly connected by a Stopcock, sharing a separate infusion pump (Figure 1b). Immediately after extubation, patients received a bolus of 10 mL of 0.2% ropivacaine in each side, and a total of 2 infusions were started (1 for each side). The total infusion was initiated at 0.3 mg/kg/h of 0.2% ropivacaine with titration up to 0.6 mg/kg/h. Titration adjustments were made by the intensive care unit (ICU) team based on the patients' reported level of pain. If the patient reported pain ≥7/10, the infusion was increased by 1 mL/h every hour bilaterally; if the patient reported pain <3/10, the infusion was reduced by 1 mL/h every hour bilaterally. The TDRN block catheters remained in place for 48 hours postoperatively and were removed by the surgical team. Gentle traction was applied similar to the way epidural catheters are removed. In addition, patients received a multimodal analgesic regimen that included a hydromorphone patient-controlled analgesia (PCA) pump, 0.1 mg with 10 minute lockout (if necessary for breakthrough pain), NSAIDs, and Tylenol as part of a standard protocol.

Figure 1. (a) Dorsal ramus nerve catheters prior to closure. (b) Dorsal ramus nerve catheters after closure (right side).

RESULTS

No complications were noted during hospitalization or in the postoperative period. Patients reported their pain was well controlled. Patients were able to participate in physical therapy, eat, and

Figure 2. (a) Normal neuromuscular anatomy of the back. (b) Intraoperative placement of thoracolumbar dorsal ramus nerve catheters. (c) Postoperative relationship between thoracolumbar dorsal ramus nerve catheters and implanted pedicle screws.

sleep with comfort. There was no respiratory depression noted. The Foley catheters were removed on the same day of surgery. The patients' postoperative opiate use was recorded (Table), and it was noted that a markedly low dose of narcotics was required while the TDRN block catheters were in place.

DISCUSSION

It is well established[4] that the dorsal rami of segmental spinal nerves supply the synovial joints of the vertebral column, the deep muscles of the back, and the overlying skin in a dermatomal pattern. After the segmental nerve exits the intervertebral foramen, it splits into dorsal and ventral rami. The dorsal rami then pass through a foramen bounded by the superior border of the transverse process, the anterior aspect of the superior zygapophysial (facet) joint, and the intertransverse ligament.[5] Thus, it accesses the paraspinal muscles (multifidus, semispinalis, spinalis, longissimus, iliocostalis). Our technique targets the dorsal rami nerves as they exit the spinal canal, before they enter the paraspinal muscles. Repositioning the paraspinal muscles places the nerves in direct contact with the implanted catheters (Figures 2a–c).

The somatic pain resulting from tissue trauma as well as reflex muscle spasms makes the surgical correction of scoliosis an extremely painful procedure. Reviewing reports of pain management protocols subsequent to posterior spinal fusion have not resulted in an accepted "standard."[6] Patients who received the TDRN block catheters were pleased with their level of pain management and were able to mobilize quickly and comfortably. Subjectively, our ICU team reported that the patients with the TDRN block catheters had improved analgesia and comfort remarkably compared with patients who received a pain regimen that used an epidural catheter. Furthermore, patient 2 required no postoperative opiates while the catheters were in place and required a rescue PCA pump upon the TDRN block catheters' removal (a total of 6.6 mg hydromorphone).

Patients who received TDRN block catheters required minimal opiates in the postoperative period and avoided affecting the blockage distribution of ventral ramus nerve and sympathetic chain. This allowed patients to participate in physical therapy as early as on postoperative day 0. This bypassed the potential untoward side effects of epidural analgesia (hypotension, lower extremity weakness, respiratory depression, and urinary retention). In addition, the TDRN block catheters can be used in the upper thoracic spine without fear of respiratory depression and may be used in cases of wide laminectomy or large vertebrectomy. Given the results, the authors believe that a larger study comparing TDRN block catheters with the standard thoracic or lumbar epidurals should be performed in the setting of a multimodal analgesic regimen. We anticipate that the rate of complications will remain low (0 in this study) with good analgesic effect in this patient population, which has typically endured extraordinary discomfort in the postoperative period.

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REFERENCES

1. Hresko MT. Idiopathic scoliosis in adolescents. *N Engl J Med*. 2013;368(9):834-841.

2. Noshchenko A, Hoffecker L, Lindley EM, et al. Predictors of spine deformity progression in adolescent

idiopathic scoliosis: a systematic review with meta-analysis. *World J Orthop*. 2015;6(7):537–558.

3. Taenzer AH, Clark C. Efficacy of postoperative epidural analgesia in adolescent scoliosis surgery: a meta-analysis. *Paediatr Anaesth*. 2010;20(2):135–143.

4. Moore KL, Dalley AF, Agur AMR. 2014 *Clinically Oriented Anatomy*. 7th ed. Philadelphia, PA: Lippincott Williams and Wilkins.

5. Linqiu Z, Carson DS, Zhenhai S. The anatomy of dorsal ramus nerves and its implications in lower back pain. *Neurosci Med*. 2012;3(2):192–201.

6. Seki H, Ideno S, Ishihara T, Watanabe K, Matsumoto M, Morisaki H. Postoperative pain management in patients undergoing posterior spinal fusion for adolescent idiopathic scoliosis: a narrative review. *Scoliosis Spinal Disord*. 2018;13:17.

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简讯

ASA成功举办2020年网络年会

曹锡清 、苗宁 供稿

中秋的首都华盛顿特区天高云淡，温暖宜人。各家各户门前摆上了盛开的金菊和硕大的南瓜，街道两旁的树梢上渐渐露出红黄相间的秋叶。夜幕降临，万里晴空，波多马克河上“东船西船悄无言，唯见江心秋月白”，正是朋友们团圆聚首之际。可是美好的岁月却被无情肆虐的新冠病毒打断了，随着疫情不断蔓延，感染和死亡人数不断攀升，原本定于10月2-5日在华府会议中心举行的ASA 2020年年会不得不改成网络会议。幸亏如此。就在ASA开幕的当天，白宫传出总统不慎感染新冠，高烧103OF需要吸氧，继而进入Walter Reed 医院治疗，幕僚们也相继检测阳性。这一来，尽管天公作美秋高气爽，可是表面祥和的空气中却弥漫着紧张焦虑，大家纷纷猜测不知大会邀请的几位重磅级Keynote 演讲者能否如期而至，第一次有13,000人参加的网络会议能否顺利不出技术意外？

第一天会议有条不紊的结束时，悬着的这颗心才放下来。我真是由衷地佩服ASA的领导力和组织缜密，所有ASA staff在后台的辛勤监管，参展医药公司的十八般武艺，各显神通。

现场聆听的讲座衔接有序，还可以当场提问与讲者互动。如果两场讲座时间重叠或与其他的PBLD、workshop、Committee meeting等有冲突时，可以24h 后听存档的OnDemand 录像。真的比往年亲临现场跑来跑去找会议室，坐在后排听不清、看不见投影仪还便捷节约时间。很多会员说网络会议效率太高了，比在历年ASA年会上参加的讲座都多，学习和发言的都到位。年会上很多CASA会员在chat box巧遇，CASA理事会成员耶鲁大学医院的李金蕾副教授讲授《骨关节置换ERAS》受到很多CASA会员好评。克利夫兰临床中心的周珊医生荣获ASA住院医生科研论文比赛三等奖（图1），在CASA会员群里大家衷心祝贺她获奖，为她热情点赞。我周六参加了两个PBLD讨论会，与会者互相交流各人所在医院的经验，疑难病例的麻醉处理包括术后ICU管理。研讨会上学习了不少新知识和听取了其他医生的经验，比如肺高压患者气管喷雾采力农的使用，ECMO并发症的鉴别诊断、各地新冠政策差异、老年人术后谵妄的预防等。另外，过去订旅馆、收拾行李、乘飞机、从机场赶往会议中心、讲者提前入场试设备等繁文缛节都统统省略了，足不出户就可以面对面交流，非常感谢Zoom的威力。当然最大的遗憾是不能与老朋友见面叙旧，不能一起共享美酒佳肴，不能亲手触摸新的仪器设备，不能参加ASA President’s Reception社交舞会和校友（住院医老友）晚会，也包括我们积极筹划的CASA年度晚会。值得庆幸的是CASA前会长汪红教授和华韵平教授代表CASA应邀参加了ASAPAC线上会议介绍CASA捐款活动（图2），表达了CASA会员对ASA参政议政项目的支持，赢得了ASAPAC领导的赞誉。

ASA大会开幕式由美国Surgeon General—Dr. Jerome Adams致辞，他是美国首位麻醉医师担任此职。他呼吁在此新冠病毒大流行肆虐期间，我们大家应抛开各自的政治倾向，团结一致对抗共同的敌人--震惊世界的COVID-19病毒。在致辞中，Dr. Adams感谢每一位麻醉工作者，包括麻醉医师，麻醉护士（CRNA）和麻醉医师助理（AA），他说：“你们每一个人冒着生命危险抢救病患，保证了各个家庭和社区的安全，你们是真正的英雄！”他为自己和我们所有麻醉工作者的贡献而自豪。

周五晚上House of Delegates 大会上年会执委会主席Dr. Megan Rosenblatt汇报了年会既是innovative又是disruptive 过程，最初担心网络会议如果收费高怕没人参加，所以报名费只有$99, 对住院医和医学生免费。没料到会这么成功，特别是广大的年轻会员包括有孩子的女医师、住院医生和医学生强烈反馈喜欢网络会议的教育方式，希望疫情过后继续以网络和亲临会场的混合方式举办各类讲座。但目前网络会议不能盈利，今年年会入不敷出。以往每年举办年会ASA净收入三百六十万，今年没有，ASA预算减少。加上预估因为疫情影响明年ASA会员会减少20%，这样ASA明年要紧巴巴的过日子了。相信ASA在新任主席Dr. Beverly Philip领导下逐步度过难关。

图 1

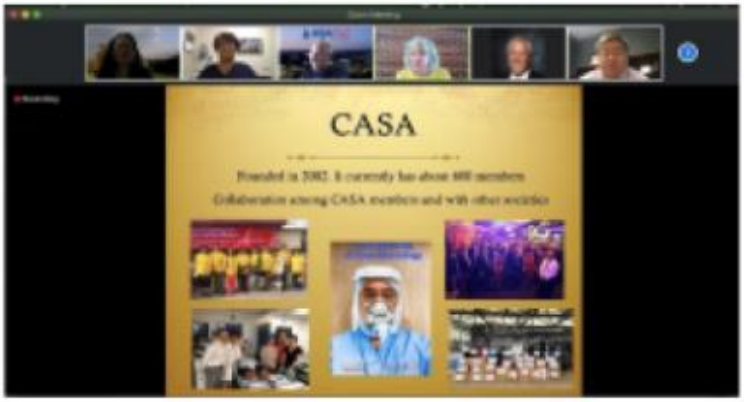

图 2

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