NORA ICU: Challenges galore

Kunal Karamchandani MD, FCCP, FCCM
Associate professor
Division of Critical Care
Department of anesthesiology and Pain management
University of Texas Southwestern medical center,
Dallas, Texas

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- Disclosures:
  - Scientific advisory board, Eagle pharmaceuticals
  - Research advisor, Philips Healthcare
- COI: None

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Learning objectives

Need

Challenges

Special considerations

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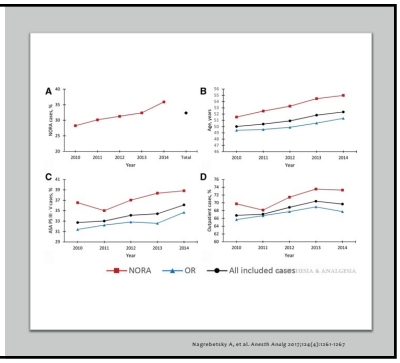
NORA growth

- 40% of all anesthetics
- 50% of all anesthetics delivered in the next decade



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NORA ICU

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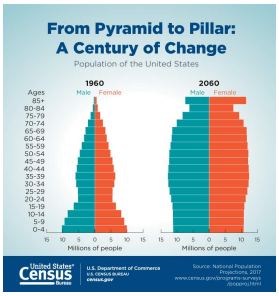
Older and sicker



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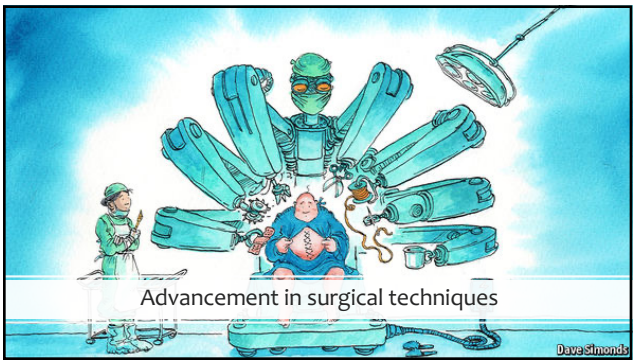

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Improvement in ICU ergonomics

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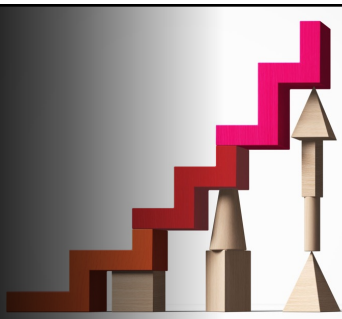
Increase in bedside ICU procedures



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- Cost savings
- Timely access
- Patient transport

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COST EFFICIENCY

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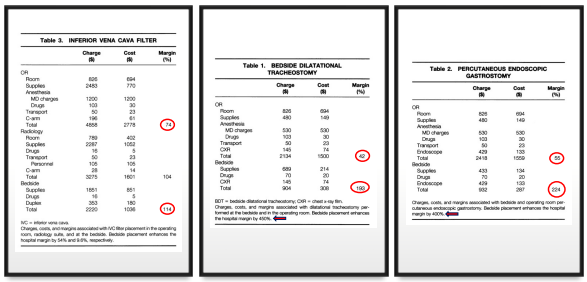

Table 3. INFERIOR VENA CAVA FILTER

	Charge ($)	Cost ($)	Margin (%)
OR			
Room	826	694	
Supplies	2455	770	
Anesthesia			
MD charges	1200	1200	
Drugs	103	30	
Transport	50	23	
C-arm	196	61	
Total	4868	2778	74
Radiology			
Room	789	402	
Supplies	2287	1052	
Drugs	16	5	
Transport	50	23	
Personnel	105	105	
C-arm	28	14	
Total	3275	1601	104
Bedside			
Supplies	1851	851	
Drugs	16	5	
Duplex	350	180	
Total	2220	1036	114

IVC = inferior vena cava.
Charges, costs, and margins associated with IVC filter placement in the operating room, radiology suite, and at the bedside. Bedside placement enhances the hospital margin by 54% and 104%, respectively.

Table 1. BEDSIDE DILATATIONAL TRACHEOSTOMY

	Charge ($)	Cost ($)	Margin (%)
OR			
Room	826	694	
Supplies	480	149	
Anesthesia			
MD charges	530	530	
Drugs	103	30	
Transport	50	23	
CXR	145	74	49
Total	2134	1500	
Bedside			
Supplies	689	214	
Drugs	70	20	
CXR	145	74	
Total	904	308	193

BDT = bedside dilatational tracheostomy; CXR = chest x-ray film.
Charges, costs, and margins associated with dilatational tracheostomy performed at the bedside and in the operating room. Bedside placement enhances the hospital margin by 193%.

Table 2. PERCUTANEOUS ENDOSCOPIC GASTROSTOMY

	Charge ($)	Cost ($)	Margin (%)
OR			
Room	826	694	
Supplies	480	149	
Anesthesia			
MD charges	530	530	
Drugs	103	30	
Transport	50	23	
Endoscope	429	133	
Total	2418	1559	55
Bedside			
Supplies	433	134	
Drugs	70	20	
Endoscope	429	107	
Total	932	261	257

Charges, costs, and margins associated with bedside and operating room percutaneous endoscopic gastrostomy. Bedside placement enhances the hospital margin by 400%.

Van Natta et al. Ann Surg. 1998 May;227(5):618-24

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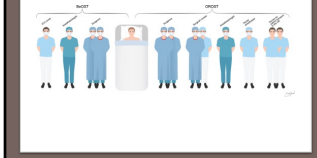
OR vs Bedside OST



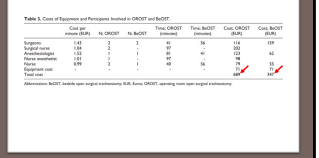


Table 3. Costs of Equipment and Participants Involved in OROST and BeDST.

	Cost per minute (EUR)	N. OROST	N. BeDST	Time, OROST (minutes)	Time, BeDST (minutes)	Cost, OROST (EUR)	Cost, BeDST (EUR)
Surgeons	1.43	2	2	41	56	116	159
Surgical nurse	1.04	2	-	97	-	202	-
Anesthesiologist	1.32	1	1	61	41	122	62
Nurse anesthetist	0.99	1	-	61	-	61	-
Nurse	0.99	2	1	40	56	79	55
Equipment cost	-	-	-	-	-	31 ✓	31 ✓
Total cost						611	307

Abbreviations: BeDST, bedside open surgical tracheostomy; EUR, Euros; OROST, operating room open surgical tracheostomy.

Sharing M, et al. Eur. Nurse & Throat Journal. May 2021

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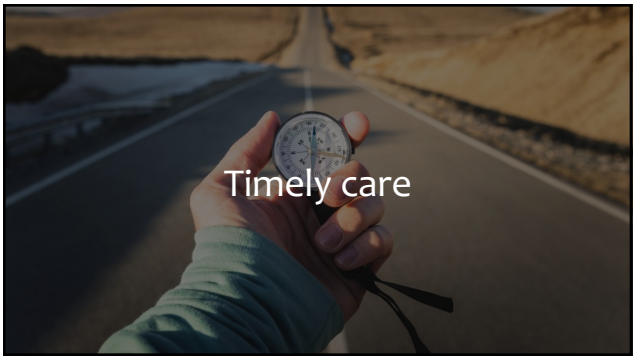

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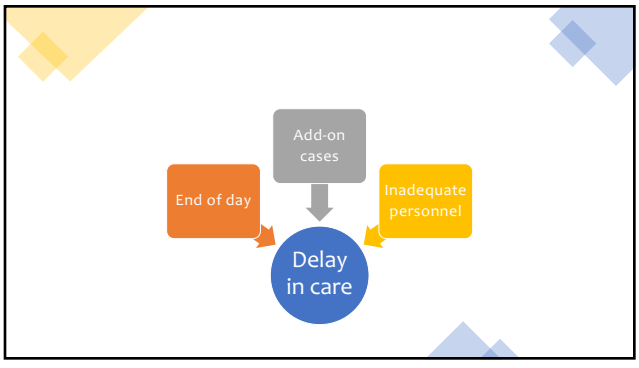

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Johns Hopkins Percutaneous Tracheostomy Program(JHPTP)

- Multi-disciplinary percutaneous tracheostomy program
- Before and after review
  - 2004 vs 2008
- 46.8% vs. 77.2% percutaneous tracheostomy at the bedside in the ICU

	Percutaneous (ICU)	Open (OR)	P-value
Number of patients	183	33	
Days to tracheostomy	1.3±1.9	5.2±5.3	<0.001
Operating time	37.2±20.2	71.1±37.4	<0.001
Anesthesiologist time	50.0±22.3	114.4±48.9	<0.001

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Our data…

- COVID patients
- OR vs Bedside open tracheostomy

	OR Tracheotomy (n=83)	Bedside Tracheotomy (n=36)	p-value
Length of intubation (days)	31 (CI 29-34)	23 (CI 18-28)	**<0.01**

Tanner Mitson BS, et al. Predictors of Mortality in Patients with COVID-19 Undergoing Tracheostomy. Under review

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- Accidental disconnections/extubations
- Technical failure of life support devices
- Increased morbidity and mortality
- Spreading contagions

Beckmann U, et al. Intensive Care Med 2004;30(8):1579-85.

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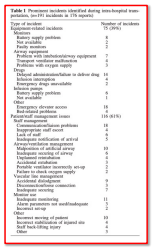
Incidents relating to the intra-hospital transfer of critically ill patients

An analysis of the reports submitted to the Australian Incident Monitoring Study in Intensive Care

- Cross-sectional case review
- Incident reports submitted to the Australian Incident Monitoring Study in Intensive Care (AIMS-ICU).
- Between 1993 and 1999
- 176 reports were submitted describing 191 incidents



Beckmann U, et al. Intensive Care Med 2004;30(8):1579-85

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All intrahospital transports (n = 262)	Number	%
Adverse events during transport	**120**	**45.8**
Patient-related adverse events during transport	**68**	**26**
Major patient-related adverse events during transport	**44**	**16.8**
Oxygen desaturation	23	8.8
Extubation	1	0.4
Accidental central venous catheter removal	1	0.4
Hemodynamic instability	13	5
Increased vasopressor dose	5	1.9
Minor patient-related adverse events during transport	**53**	**20.2**
Agitation	38	14.5
Accidental nasogastric tube pull out	1	0.4
Vomiting	3	1.1
Peripheral venous catheter incident	4	1.5
Central venous catheter incident	6	2.3
Arterial line incident	5	1.9
Accidental dislodging of urinary catheter	1	0.4
Disconnection of endotracheal tube and airway equipment	2	0.8
Equipment-related incidents during transport	**86**	**32.8**
Incident with airway equipment (alarm, adjustment)	46	17.6
Incident with monitor (battery, alarm)	45	17.2
Incident with infusion pumps (battery, alarm)	18	6.9

Incidents occurring during intrahospital transfer	Location of incident	Number (%)
Near-extubation	CT	5
Arterial line detached and near-removal	CT	3
Monitor battery flat	CT and MRI	2
Patient increased secretions but no suction device to use	CT and transit to CT	2
Oxygen cylinder completely empty	Transit to OT	1
Underwater seal drain detached	CT	1
Total		14 (43.75)

Winter M W , Anaesth Intensive Care. 2010 May;38(3):543-9.
Parmentier-Decrucq E, et al. Ann Intensive Care. 2013 Apr 11;3(1):10.

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Which patients?

What procedures?

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OR costs and transport risks are not justified

- Tracheostomy
- PEG tube insertion
- IVC filter placement

Emergent procedures in unstable patients

- Laporatomy
- Hemorrhage control
- Debridement and irrigation of wounds
- Temporary fracture stabilization

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- TRACHEOSTOMY
- Percutaneous placement of enteral feeding tubes
- Application or realignment of external fixation of fractures
- Surgical dressing changes
- Endoscopic interventions
  - Occult bleeding
  - Hemorrhage control
  - Pancreato-biliary pathologies
- Exploratory laparotomy
- Closure of open cavities
- Invasive diagnostic procedures
- Insertion or removal of invasive life support equipment (ECMO, IABP, VAD etc.)
- Fasciotomy for compartment syndrome
- Wound debridement
- Pericardiocentesis

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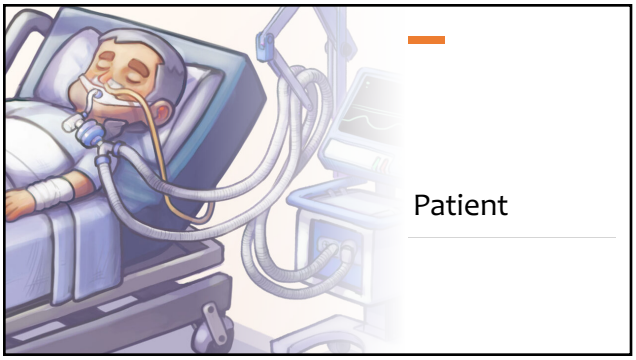

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Higher acuity patients

"Too sick for the OR"

Intra-hospital transfer

Preventable adverse events

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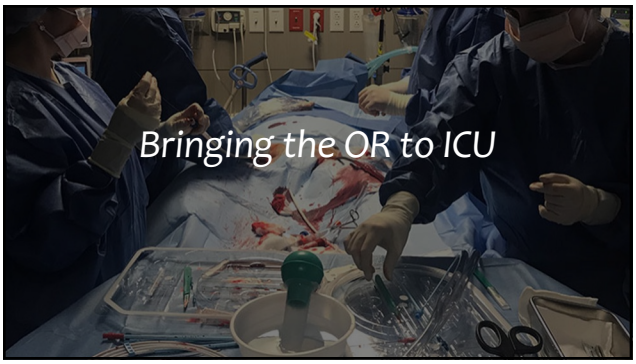

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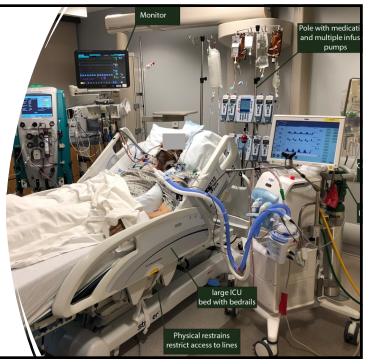
Challenges

- Patient related
- Spatial and ergonomic challenges
- Personnel and staffing challenges
- Resource allocation and reimbursement



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Patient related

Consent/code status (Patient/HCPOA)

Airway

- Secured
  - Confirm tube position
  - Ensure tube patency
- Unsecured
  - Physiologically difficult airway
    - Pre-oxygenation
    - Optimize patient position
    - Rescue plans
    - Beware of hemodynamic collapse

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Mechanical ventilation

- Continue the same mode and settings
- Work with the RT

Hemodynamics

- Preoperative POCUS
- Increase dose of pressors

Renal

- Electrolytes
- Drug clearance/metabolism
- RRT
  - If CRRT, continue and avoid fluid removal
  - If IHD (last session, fluid removal)

33

Heme

- Coagulation status
- Blood and blood products

Endocrine

- Stress hyperglycemia
- Relative adrenal insufficiency

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	Challenges	Management considerations
Airway	• Anatomic, physiologic, and logistical difficulties	• Preparation for a difficult airway • Pre-oxygenation and apneic oxygenation
Cardiovascular	• Underlying cardiovascular pathology • Dysrhythmias • Shock due to multiple etiologies • Inotropic and pressor requirements	• POCUS to assess volume status, cardiac function, and valvular pathology • Continue vasopressors and inotropes • Invasive hemodynamic monitoring (if not already present)
Pulmonary	• Hypoxia/hypercarbia • Atelectasis, V/Q mismatch, shunt • Mechanical ventilation	• Consider HFNO and NIV in non-intubated patients • Continue same settings of MV
Neurological	• Presence of impaired neurologic function due to ICU delirium or metabolic derangements • Critical care neuropathy/myopathy • Increased ICP	• Avoid neuromuscular blockade if possible • Avoid benzodiazepines (worsen delirium) • Identify hemodynamic goals
Renal	• Altered drug metabolism • Electrolyte and acid-base disturbances • Volume shifts in patients requiring RRT	• Optimize electrolytes and acid-base imbalance (if time permits) • Avoid/decrease dose of renally cleared drugs
Endocrine	• Relative adrenal insufficiency • Stress hyperglycemia	• Stress dose steroids • Frequent blood sugar checks
Hematologic	• Anemia due to critical illness and/or blood loss • Coagulopathy	• Correct coagulopathy prior to procedure • Ensure availability of blood and blood products
Gastrointestinal	• Risk of aspiration • Minimizing disruption in nutrition	• Consider rapid sequence intubation • **Continue TPN** • **Continue post-pyloric feeding** • **Hold gastric feeds 6 hrs. prior to the procedure**

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Spatial and ergonomic

Patient rooms are not designed as operating rooms

Absence of 'standard' anesthesia equipment

- Anesthesia machine
- Drug/supply carts

Physical limitations

- Access to airway
- Access to IV

Hemodynamic data integration with AIMS

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Personnel and staffing

- Medical complexity
- Discrete location
- Special isolation precautions

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Staffing models

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Solo anesthesiologists or anesthesiologist-intensivists

Medical direction (residents, CRNA or AA)

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Delivery of Anesthesia

TIVA vs. *Volatile*

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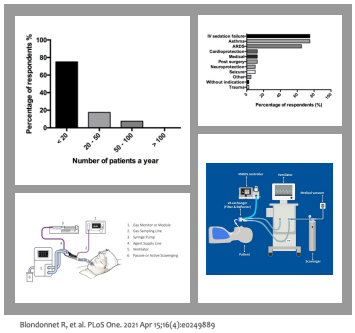

Blondonnet R, et al. PLoS One. 2021 Apr 15;16(4):e0249889

Volatile anesthetics in the ICU

- Growing interest
  - Refractory bronchospasm
  - Long term sedation
  - ?Procedures in the ICU
- Limiting factors
  - Scavenging (AnaConDA, Mirus)
  - Spatial constraints
  - Personnel familiarity

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Silver lining…

- Identical monitoring capabilities
- Advanced ventilators
- Trained personnel
  - Critical care nurses
  - Respiratory therapists

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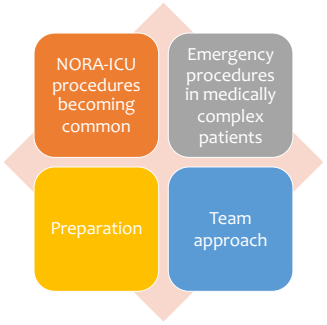
Take home points



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