Krista L. Haines, DO, MA
Assistant Professor of Surgery
Assistant Professor of Population Health
Trauma, Acute, and Critical Care Surgery
Medical Director of Ethics
Duke University Hospital, Durham, NC, USA
DrKristalHaines

The Road to Better Outcomes in Surgery

1

Disclosures

Grant Funding and Speaking: Nutrition Trauma and Aging

- NIH
- DOD
- ASPEN
- Abbott
- Baxter
- Fresenius

I have permission to use these stories and images

2


Objective
EN
ORAL
PRE-HOSPITAL
DrKristalHaines

3


Why am I talking about this?
DrKristalHaines

4


Why am I talking about this?
How did we get here?
DrKristalHaines

5


Ian
61-year-old
Difficulty Swallowing
DrKristalHaines

6

Esophageal Mass

al

7

Esophageal Mass

T3N1M0 Distal Esophageal Cancer

8

Plan: Curative Intent

Neoadjuvant chemoradiation (CROSS-type)

Restaging

Esophagectomy

9

9

Scheduled for Surgery

Preop Evaluation

Orthostatic

Sent to ED

10

Admitted

Hypotension

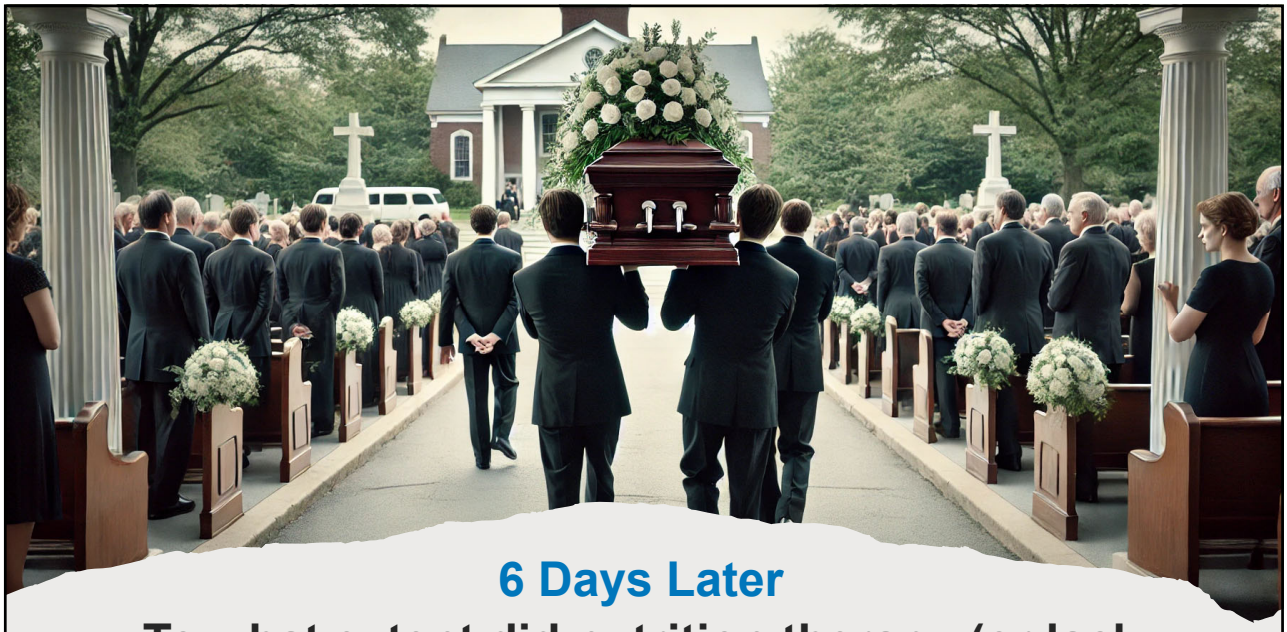
Severely Malnourished

11

11

12

12



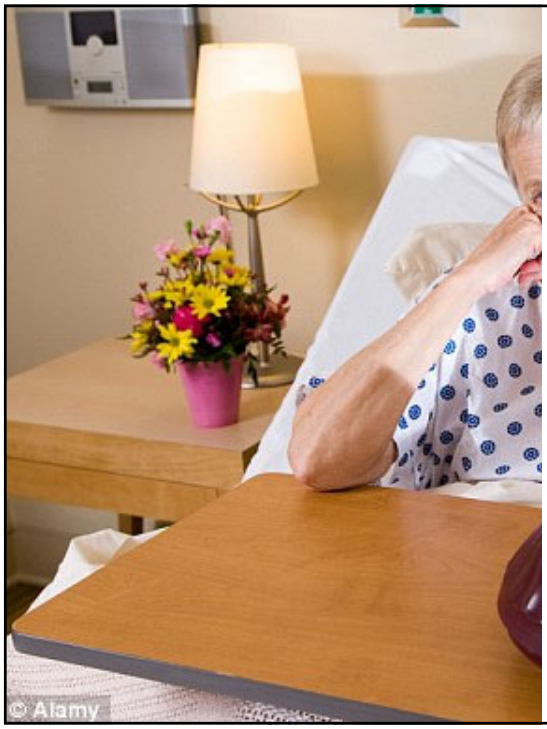
6 Days Later

To what extent did nutrition therapy (or lack there of) play a role in this patient's death?

13

Prevalence of Surgical Malnutrition

14



Pts Undergoing GI Surgery are Malnourished

Lobo, D et al. Curr Opin in Anesthes, 24; 2011

15

16

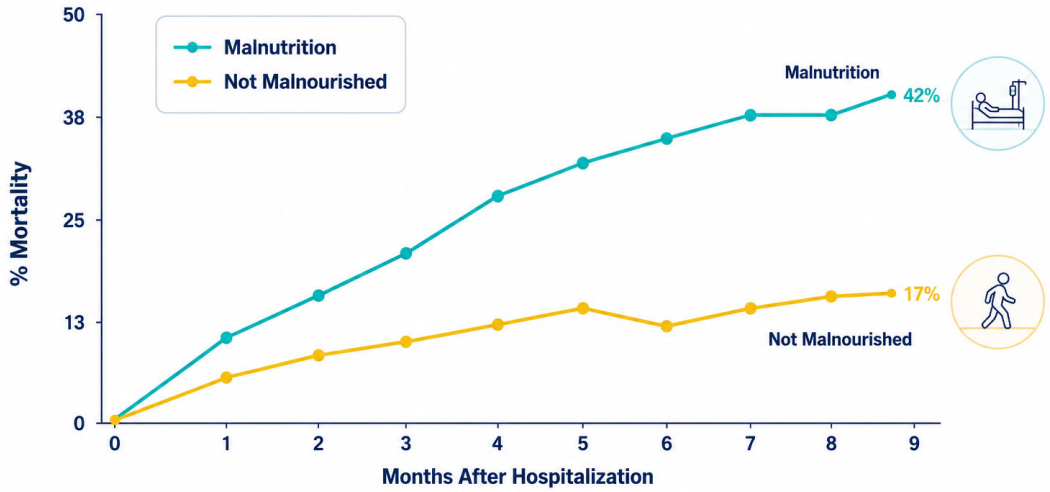
Key NSQIP Variables Predicting 30-d Mortality in Inpatient Elective Operations by Age

Variable	All patients	Age 18–69	Age 70+
Funct. Status	1	1	1
ASA class	2	2	2
Dissem. CA	3	3	4
Albumin < 35	4	4	5
Sepsis	5	5	3
DNR Order	6	12	6
BMI	7	15	10
Creat > 1.2	8	8	9
Work RVU	9	11	7
Ascites	10	7	8

Courtesy of C. Gajdos and UCH SOARES grp

17

Cumulative Mortality



Malnutrition is associated with significantly higher long-term mortality after hospitalization.

Modified from American Journal of Medicine (Cederholm T, Jägrén C, Hellström K. 1995;98:67-74).

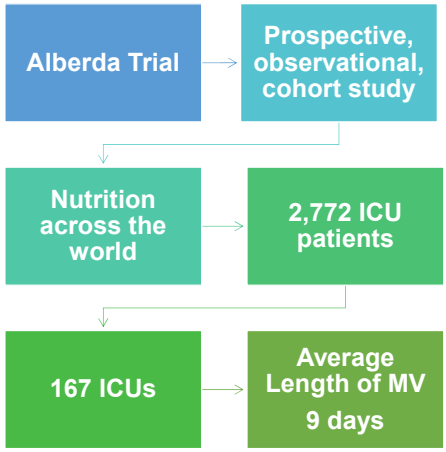
18

Intensive Care Med (2009) 35:1728–1737
DOI 10.1007/s00134-009-1567-4

ORIGINAL

Cathy Alberda
Leah Gramlich
Naomi Jones
Khursheed Jeejeebhoy
Andrew G. Day
Rupinder Dhaliwal
Daren K. Heyland

The relationship between nutritional intake and clinical outcomes in critically ill patients: results of an international multicenter observational study



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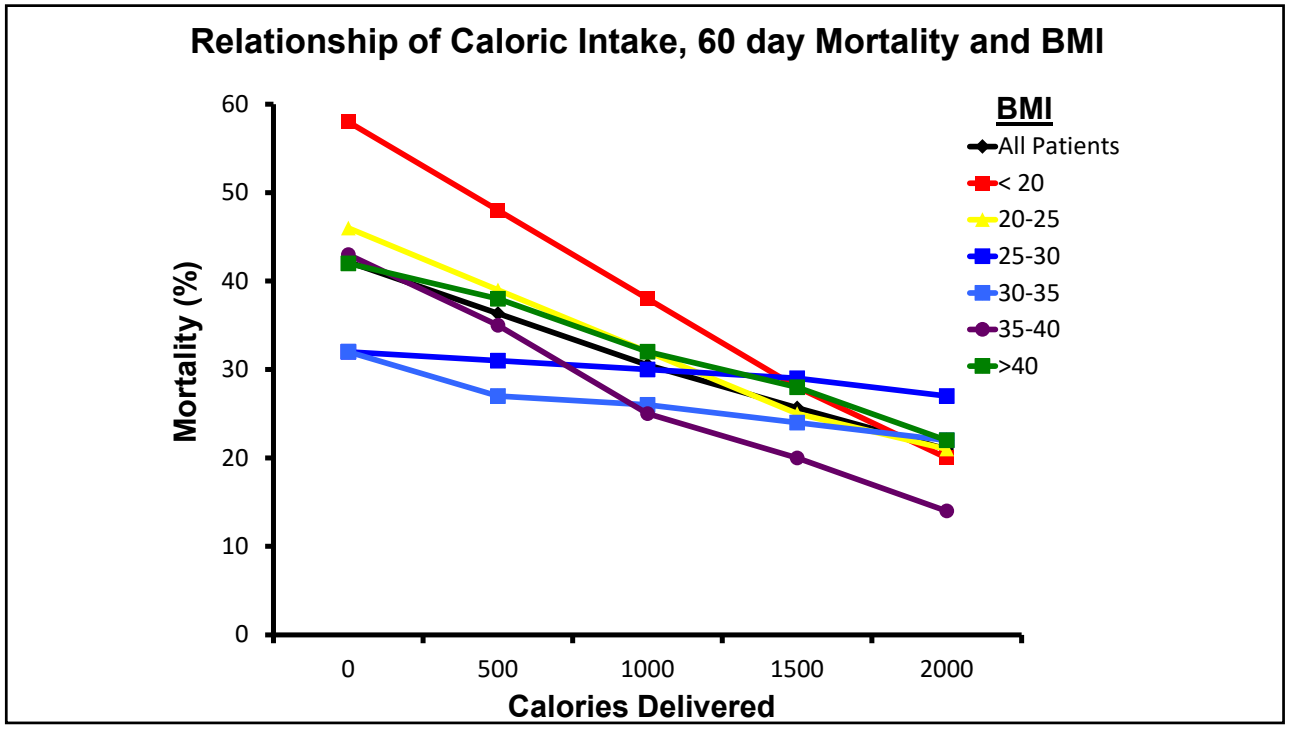

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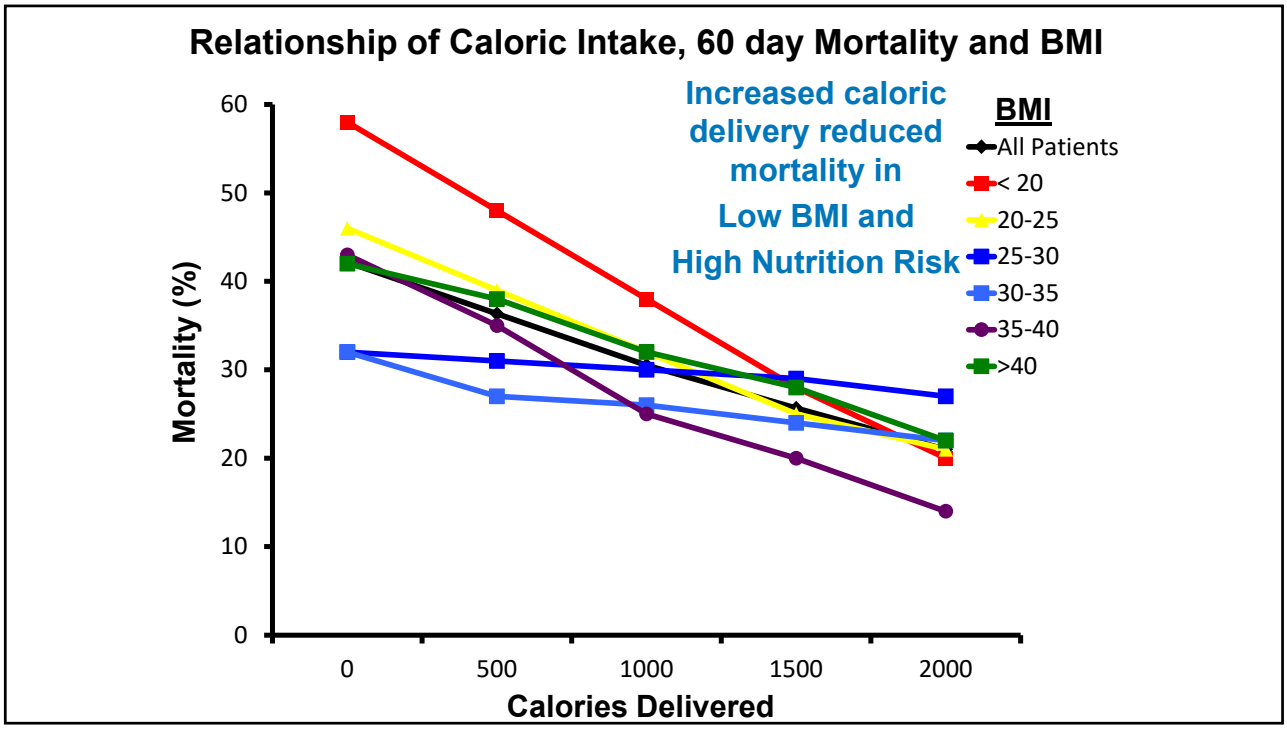
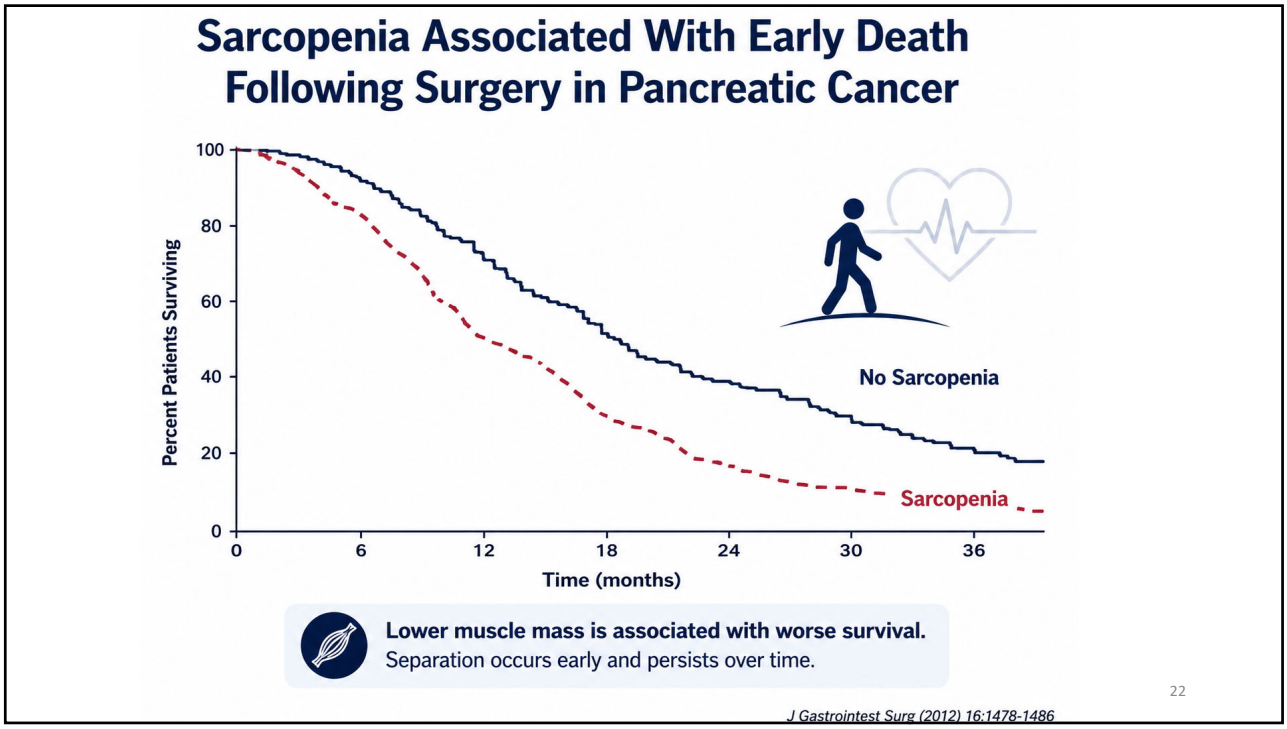

Relationship of Caloric Intake, 60 day Mortality and BMI
Increased caloric delivery reduced mortality in Low BMI and High Nutrition Risk
BMI
All Patients
< 20
20-25
25-30
30-35
35-40
>40
Mortality (%)
60
50
40
30
20
10
0
0
500
1000
1500
2000
Calories Delivered

21


Sarcopenia Associated With Early Death Following Surgery in Pancreatic Cancer
Percent Patients Surviving
100
80
60
40
20
0
0
6
12
18
24
30
36
Time (months)
No Sarcopenia
Sarcopenia
Lower muscle mass is associated with worse survival.
Separation occurs early and persists over time.
22
J Gastrointest Surg (2012) 16:1478-1486

22

PERIOPERATIVE MEDICINE

American Society for Enhanced Recovery and Perioperative Quality Initiative Joint Consensus Statement on Nutrition Screening and Therapy Within a Surgical Enhanced Recovery Pathway

Wischmeyer, Paul E. MD, EDIC[*]; Carli, Franco MD, MPhil[†]; Evans, David C. MD, FACS[‡]; Guilbert, Sarah RD, LDN, CNSC[§]; Kozar, Rosemary MD, PhD[‖]; Pryor, Aurora MD, FACS[¶]; Thiele, Robert H. MD[#]; Everett, Sotiria EdD, RD[**]; Grocott, Mike BSc, MBBS, MD, FRCA, FRCP, FFICM[††,‡‡,§§,‖‖]; Gan, Tong J. MD, MHS, FRCA[¶¶]; Shaw, Andrew D. MB, FRCA, FCCM, FFICM[##,***]; Thacker, Julie K. M. MD[†††]; Miller, Timothy E. MB, ChB, FRCA[‡‡‡]

Anesthesia & Analgesia 126(6):p 1883-1895, June 2018.

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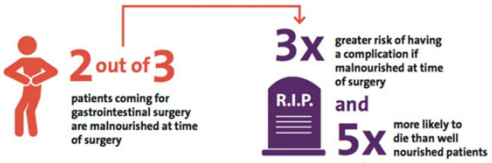

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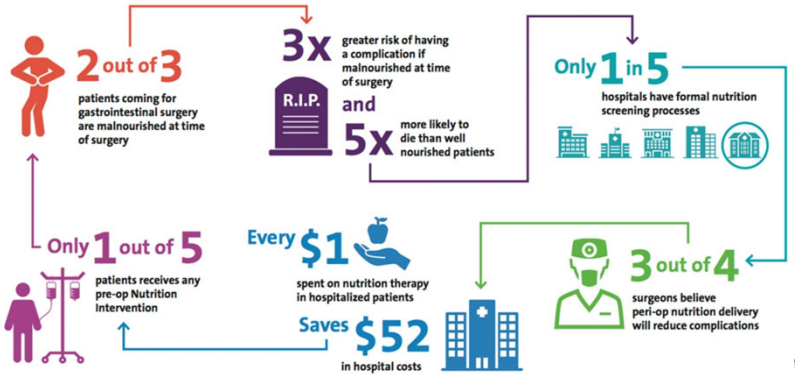

28

Modified GLIM in Emergent GI Surgery

NSQIP Cohort (n = 31,029)

PHENOTYPIC
- **BMI** (age dependent)
- **Weight loss** > 10% within 6 months

BIOCHEMICAL (PROXY)
- **Albumin ≤ 3.5 g/dL**

ETIOLOGIC
- **Emergent bowel surgery** (acute disease / injury)

Adapted GLIM for acute surgical population using NSQIP variables

Haines KL et al. Clinical Nutrition. 2021;40(3):1367-1375.

29

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NSQIP Cohort (2011–2016)
31,029 emergent bowel surgery patients | mGLIM malnutrition: 1.7% (*n* = 517)

1 Longer Length of Stay (LOS)

Longer LOS after colon surgery

1.93–4.33 days

Adjusted mean difference (95% CI): 1.93–4.33 days
p < 0.001

2 Higher In-Hospital Mortality

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Malnutrition, as defined by modified GLIM criteria, is associated with longer hospital stays and higher in-hospital mortality in patients undergoing emergent GI surgery.

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30

Why do we Care...

31

Why do we Care...

They Die . . .

Nutritional Status
Only Modifiable
Risk Factor
We Can Affect
Pre-Operatively to
Reduce Mortality

32

33

GLIM Criteria for the Diagnosis of Malnutrition

Global Leadership Initiative on Malnutrition (2016)

A global consensus by ASPEN, ESPEN, FELANPE, and PENSA to provide a standardized, evidence-informed approach to identify malnutrition in clinical practice and research.

1. PHENOTYPIC CRITERIA

At least 1 of the following

Unintentional Weight Loss
- >5% within past 6 months OR
- >10% beyond 6 months

Low Body Mass Index (BMI)
- <20 kg/m² if <70 years
- <22 kg/m² if ≥70 years

Reduced Muscle Mass
- Measured by validated body composition techniques (e.g., DXA, CT, BIA)

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2. ETIOLOGIC CRITERIA

At least 1 of the following

Reduced Food Intake or Absorption
- ≤50% of energy requirements for >1 week OR
- Any reduction for >2 weeks OR
- Chronic GI condition that adversely impacts food assimilation or absorption

Disease Burden / Inflammation
- Acute disease/injury or
- Chronic disease with inflammation (e.g., cancer, COPD, CKD, IBD, chronic infections)

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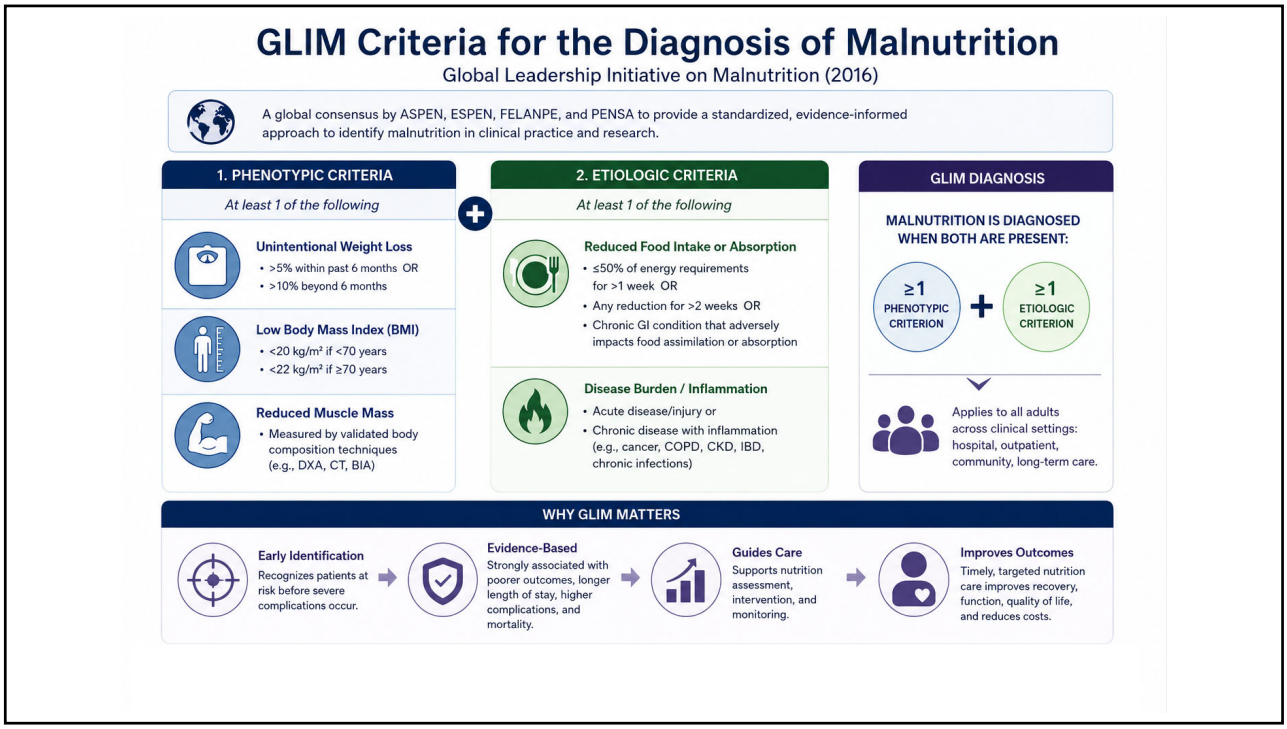
GLIM DIAGNOSIS

MALNUTRITION IS DIAGNOSED WHEN BOTH ARE PRESENT:

≥1 PHENOTYPIC CRITERION + ≥1 ETIOLOGIC CRITERION

Applies to all adults across clinical settings: hospital, outpatient, community, long-term care.

36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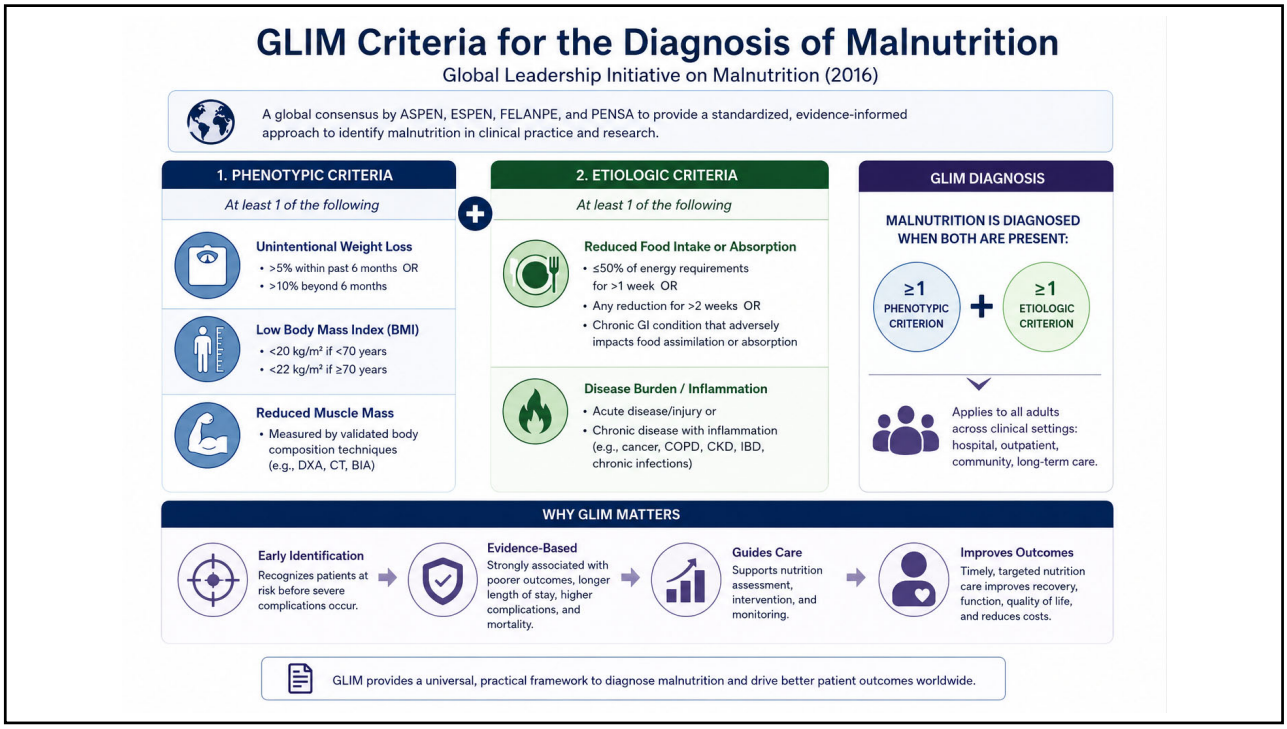
+
≥1 ETIOLOGIC CRITERION
Applies to all adults across clinical settings: hospital, outpatient, community, long-term care.
WHY GLIM MATTERS
Early Identification
Recognizes patients at risk before severe complications occur.
Evidence-Based
Strongly associated with poorer outcomes, longer length of stay, higher complications, and mortality.
Guides Care
Supports nutrition assessment, intervention, and monitoring.
Improves Outcomes
Timely, targeted nutrition care improves recovery, function, quality of life, and reduces costs.

37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GLIM provides a universal, practical framework to diagnose malnutrition and drive better patient outcomes worldwide.

38

We Now Have GLIM. But Does It Work?

A global standard is only valuable if it leads to better recognition, better decisions, and better outcomes.

What does the evidence show when GLIM is applied in clinical practice?

Let's look at the real-world evidence.

Does using GLIM improve identification of malnutrition, influence management, and translate into better patient outcomes?

GLIM
GLOBAL LEADERSHIP INITIATIVE ON MALNUTRITION

39

HERE IS SOME DATA

40

HERE IS SOME DATA

Why Postoperative Data?

We cannot identify malnutrition and choose not to treat it.

41

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Modified GLIM Identifies Malnourished Lung Cancer Patients at Higher Risk

AFTER LUNG RESECTION

STUDY POPULATION
Lung cancer patients undergoing lung resection

DESIGN
Retrospective cohort study using NSQIP 2015–2020
n = 10,912 patients

MODIFIED GLIM CRITERIA

Phenotypic Criteria (≥1)
- Low BMI
- Recent weight loss

Etiologic Criteria (≥1)
- Hypoalbuminemia

mGLIM-defined malnutrition was independently associated with worse outcomes after both lobectomy and pneumonectomy.

44

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INDEPENDENTLY ASSOCIATED WITH HIGHER RISK OF:

PROLONGED LENGTH OF STAY (>7 DAYS)	30-DAY MORTALITY
aOR 1.58 (95% CI 1.45–1.73)	aOR 1.86 (95% CI 1.45–2.39)

KEY TAKEAWAY

Modified GLIM criteria identify lung cancer patients at higher risk for complications, longer recovery, and mortality after lung resection.

Haines K, Jiang K, Penmetsa M, et al. Evaluation of malnutrition's influence on lung cancer patients undergoing lung resection using modified GLIM criteria. Clinical Nutrition ESPEN. 2024;59;37-45.

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INDEPENDENTLY ASSOCIATED WITH HIGHER RISK OF:

POSTOPERATIVE PULMONARY COMPLICATIONS	PROLONGED LENGTH OF STAY (>7 DAYS)	DISCHARGE TO FACILITY	30-DAY READMISSION	30-DAY MORTALITY
aOR 1.45 (95% CI 1.29–1.63)	aOR 1.58 (95% CI 1.45–1.73)	aOR 1.53 (95% CI 1.40–1.66)	aOR 1.53 (95% CI 1.40–1.66)	aOR 1.86 (95% CI 1.45–2.39)

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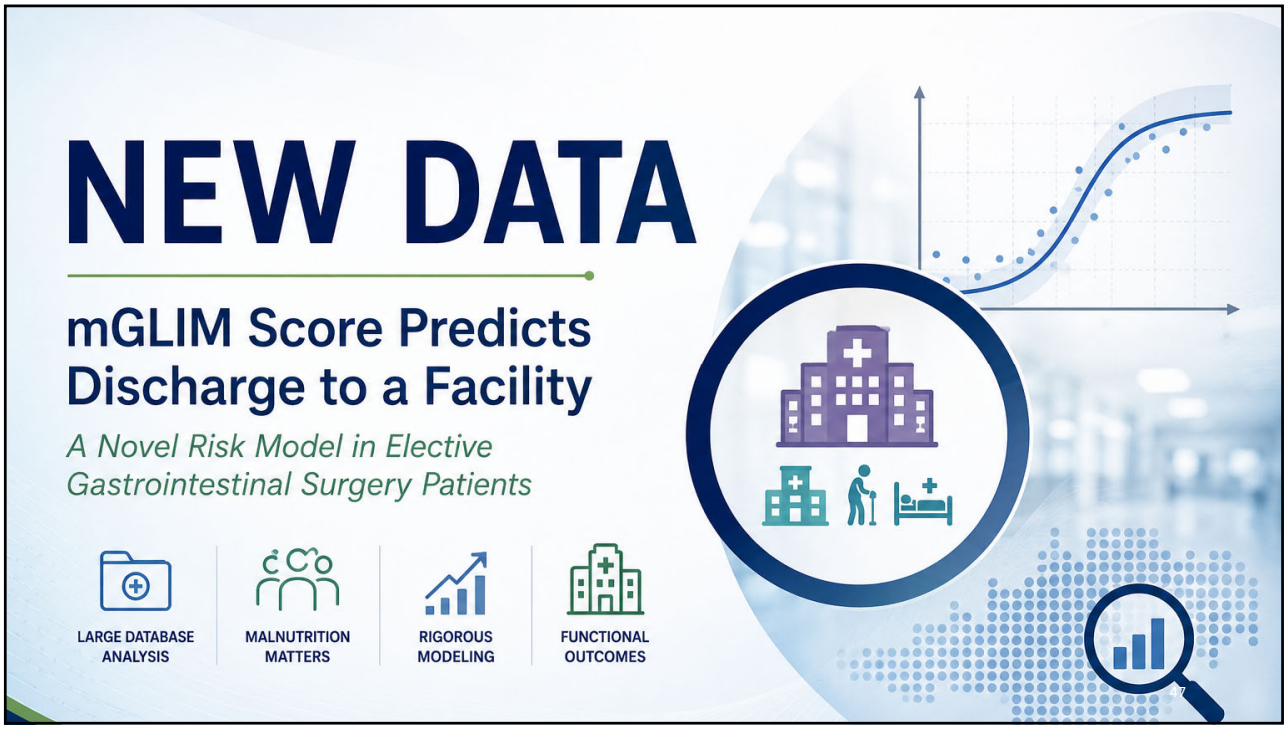
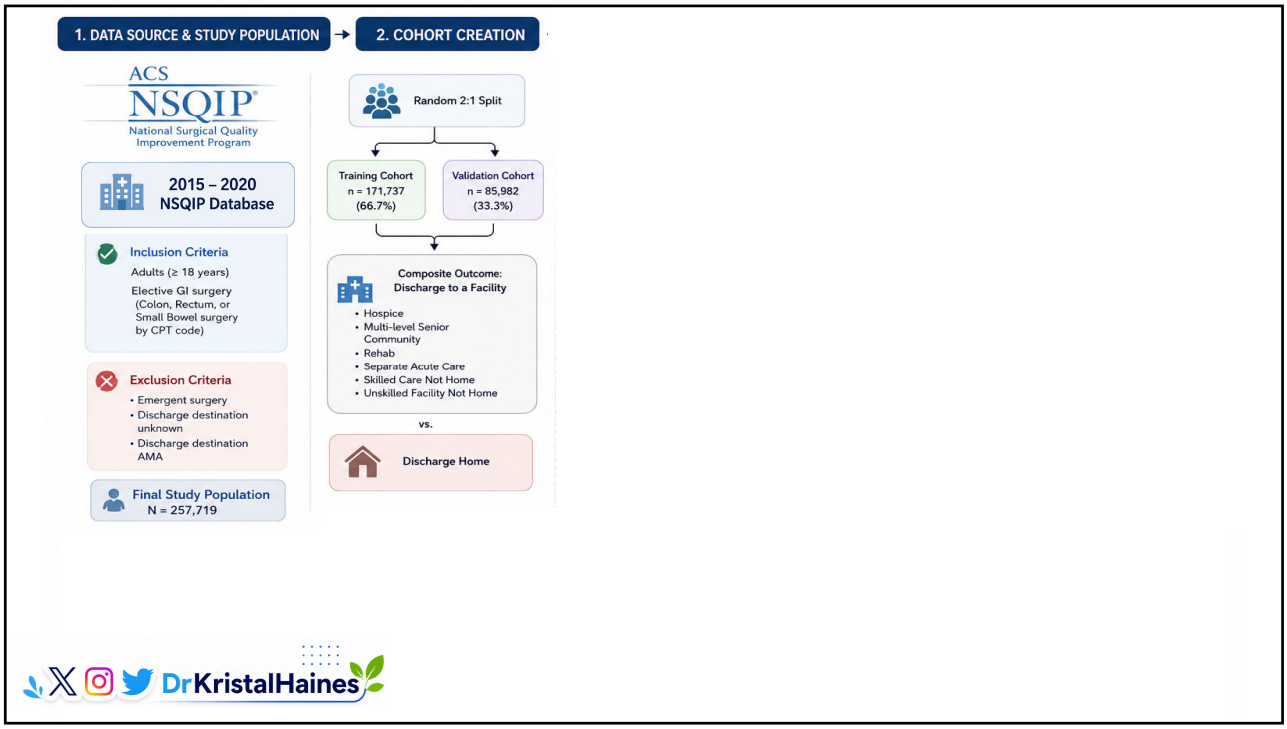

NEW DATA
mGLIM Score Predicts Discharge to a Facility
A Novel Risk Model in Elective Gastrointestinal Surgery Patients
LARGE DATABASE ANALYSIS
MALNUTRITION MATTERS
RIGOROUS MODELING
FUNCTIONAL OUTCOMES

47


1. DATA SOURCE & STUDY POPULATION
ACS NSQIP
National Surgical Quality Improvement Program
2015 – 2020 NSQIP Database
Inclusion Criteria
Adults (≥ 18 years)
Elective GI surgery (Colon, Rectum, or Small Bowel surgery by CPT code)
Exclusion Criteria
• Emergent surgery
• Discharge destination unknown
• Discharge destination AMA
Final Study Population
N = 257,719
DrKristalHaines

48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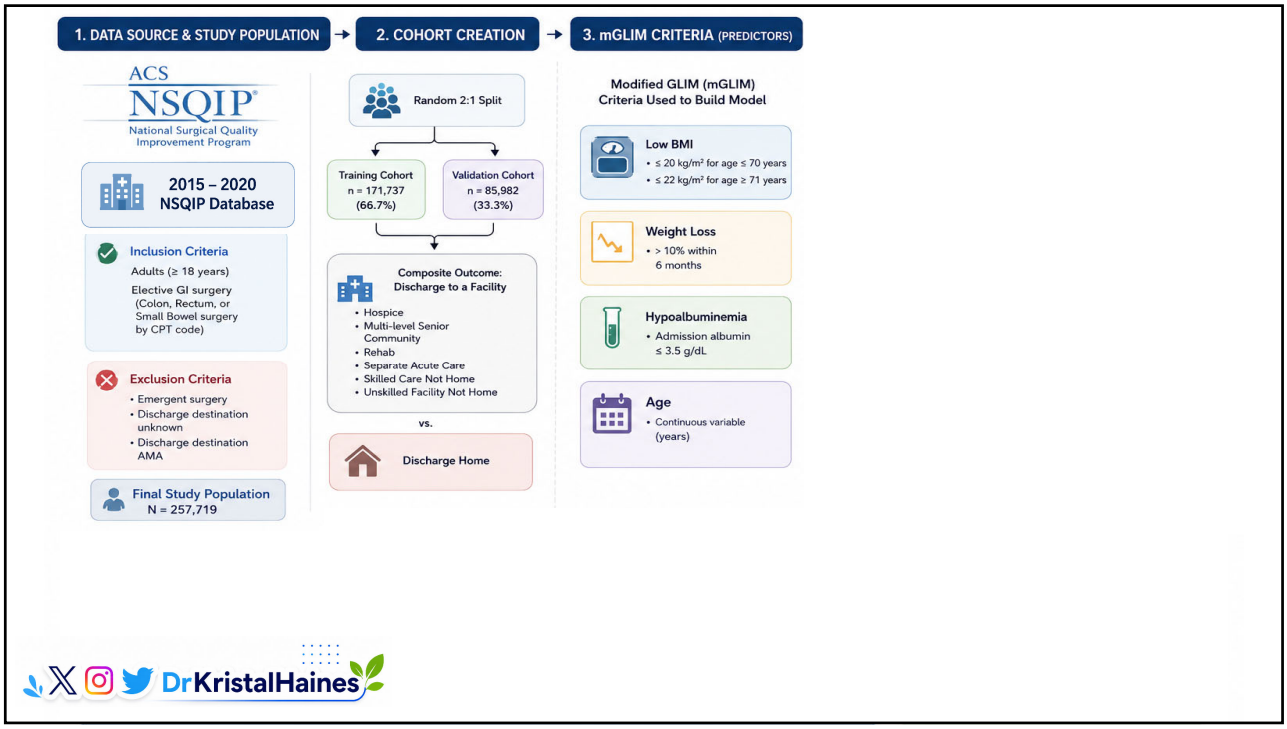
• Discharge destination AMA
Final Study Population N = 257,719
Random 2:1 Split
Training Cohort n = 171,737 (66.7%)
Validation Cohort n = 85,982 (33.3%)
Composite Outcome: Discharge to a Facility
• Hospice
• Multi-level Senior Community
• Rehab
• Separate Acute Care
• Skilled Care Not Home
• Unskilled Facility Not Home
vs.
Discharge Home
DrKristalHaines

49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2. COHORT CREATION
3. mGLIM CRITERIA (PREDICTORS)
ACS NSQIP
National Surgical Quality Improvement Program
2015 – 2020 NSQIP Database
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Random 2:1 Split
Training Cohort n = 171,737 (66.7%)
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Composite Outcome: Discharge to a Facility
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• Rehab
• Separate Acute Care
• Skilled Care Not Home
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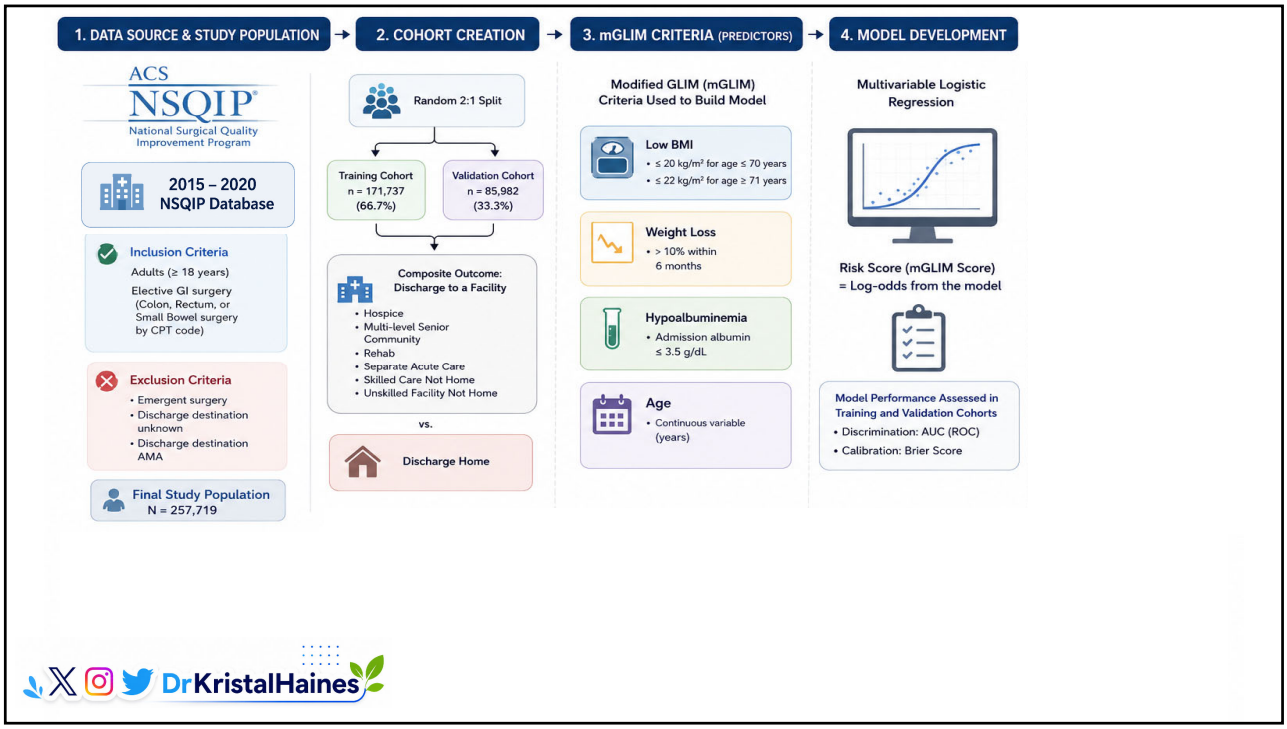
vs.
Discharge Home
Modified GLIM (mGLIM) Criteria Used to Build Model
Low BMI
• ≤ 20 kg/m² for age ≤ 70 years
• ≤ 22 kg/m² for age ≥ 71 years
Weight Loss
• > 10% within 6 months
Hypoalbuminemia
• Admission albumin ≤ 3.5 g/dL
Age
• Continuous variable (years)
DrKristalHaines

50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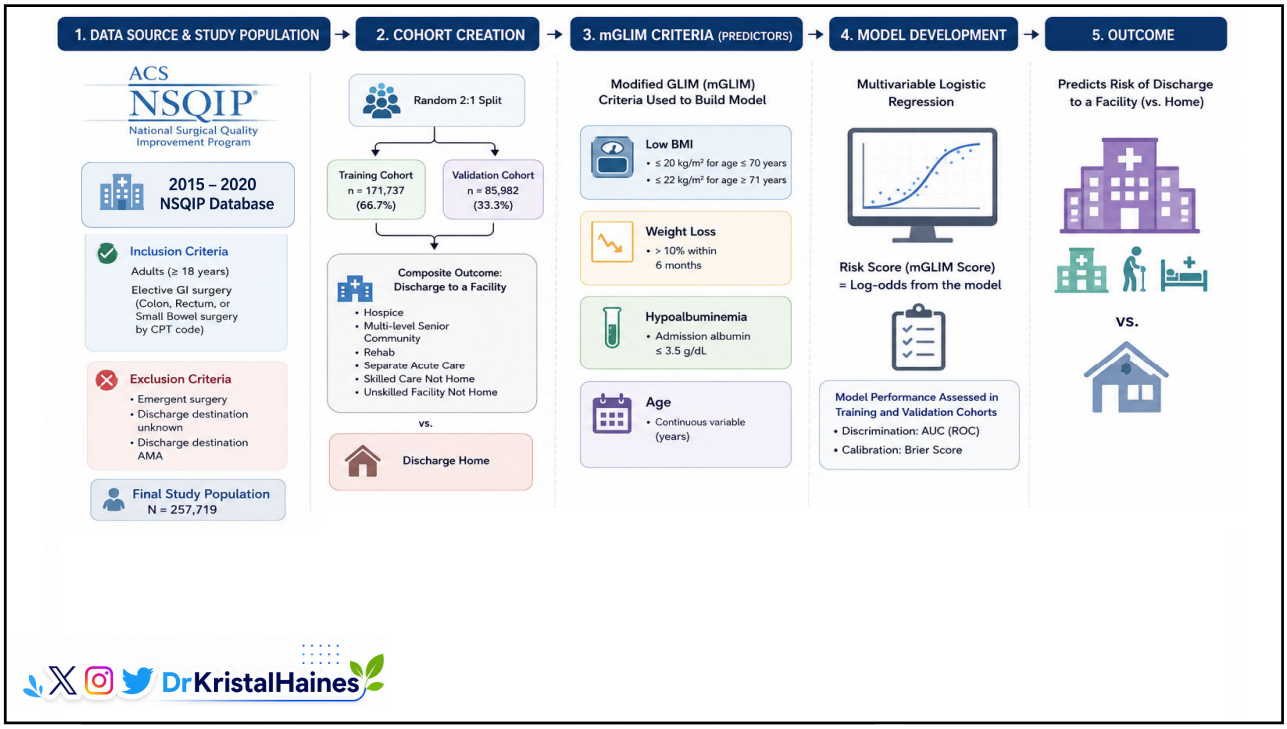
• Calibration: Brier Score
DrKristalHaines

51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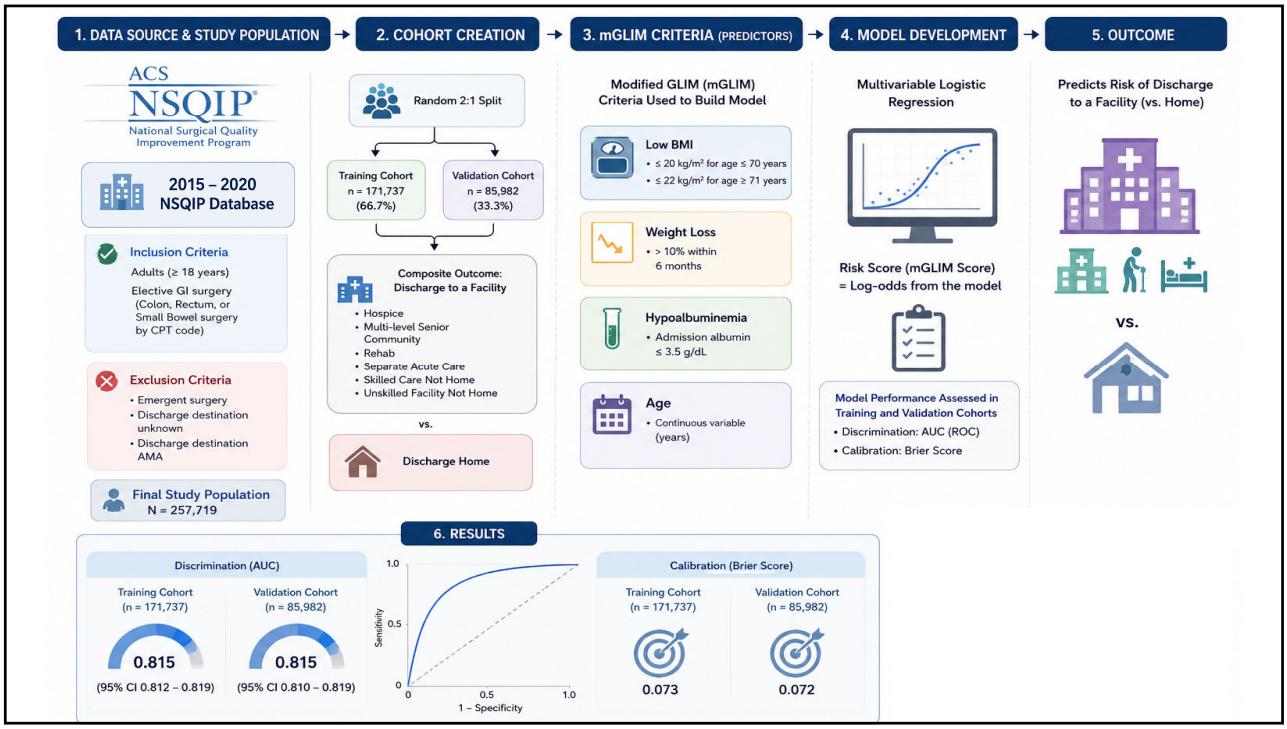
DrKristalHaines

52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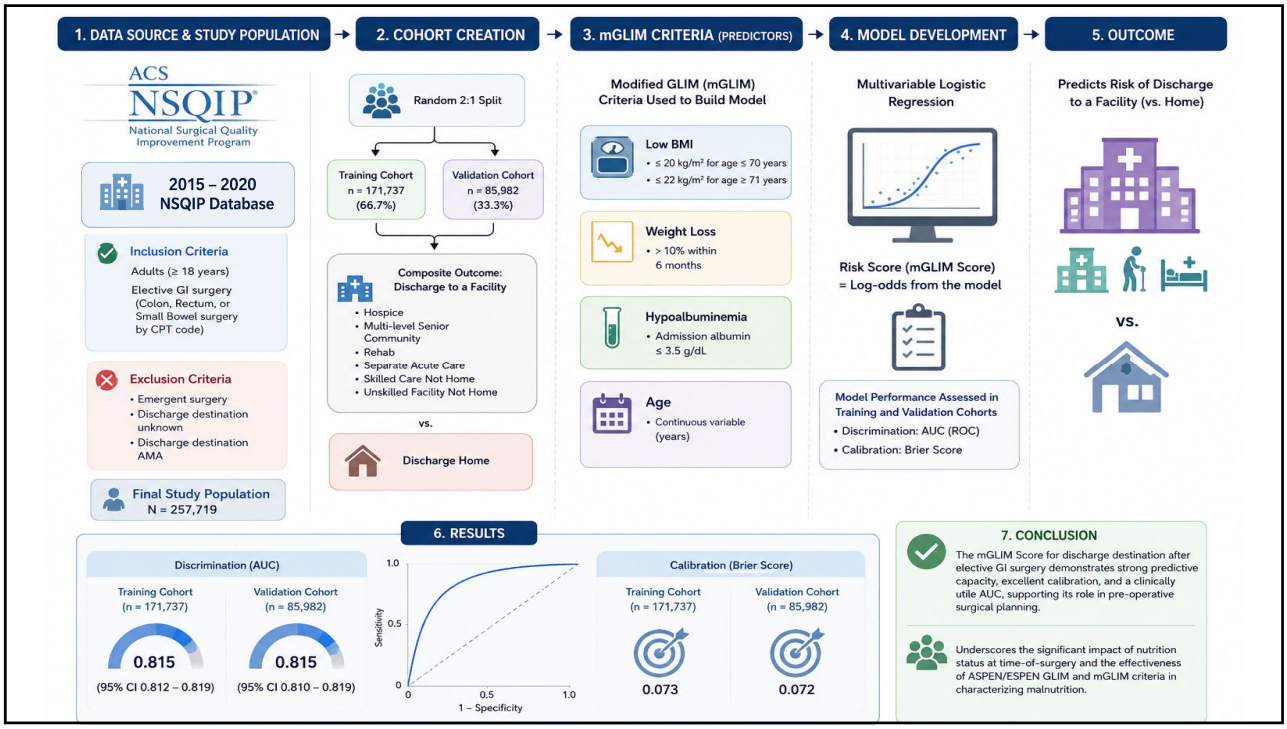
6. RESULTS
Discrimination (AUC)
Training Cohort (n = 171,737)
0.815
(95% CI 0.812 – 0.819)
Validation Cohort (n = 85,982)
0.815
(95% CI 0.810 – 0.819)
Sensitivity
1 – Specificity
0
0.5
1.0
Calibration (Brier Score)
Training Cohort (n = 171,737)
0.073
Validation Cohort (n = 85,982)
0.072

53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0.072
7. CONCLUSION
The mGLIM Score for discharge destination after elective GI surgery demonstrates strong predictive capacity, excellent calibration, and a clinically utile AUC, supporting its role in pre-operative surgical planning.
Underscores the significant impact of nutrition status at time-of-surgery and the effectiveness of ASPEN/ESPEN GLIM and mGLIM criteria in characterizing malnutrition.

54

2015 – 2020
NSQIP Database

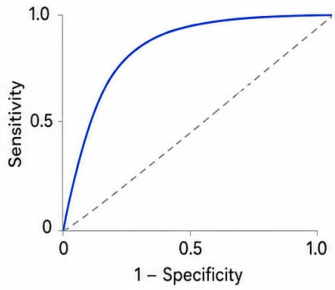
FINAL OUTCOME

Predicting Discharge Destination After Elective GI Surgery

RESULTS

PREDICTIVE PERFORMANCE

AUC



0.815 AUC

CALIBRATION
(BRIER SCORE)

Training Cohort (n = 171,737)	Validation Cohort (n = 85,982)
0.073	0.072

Strong model performance

CONCLUSION

STRONG PREDICTIVE POWER

mGLIM Score predicts discharge destination effectively.

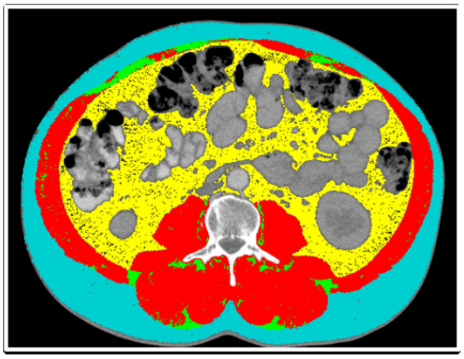
NUTRITION MATTERS

Nutrition status at time-of-surgery impacts discharge destination.

55

CT Lean Body Mass Analysis

Measured at L3 Vertebrae

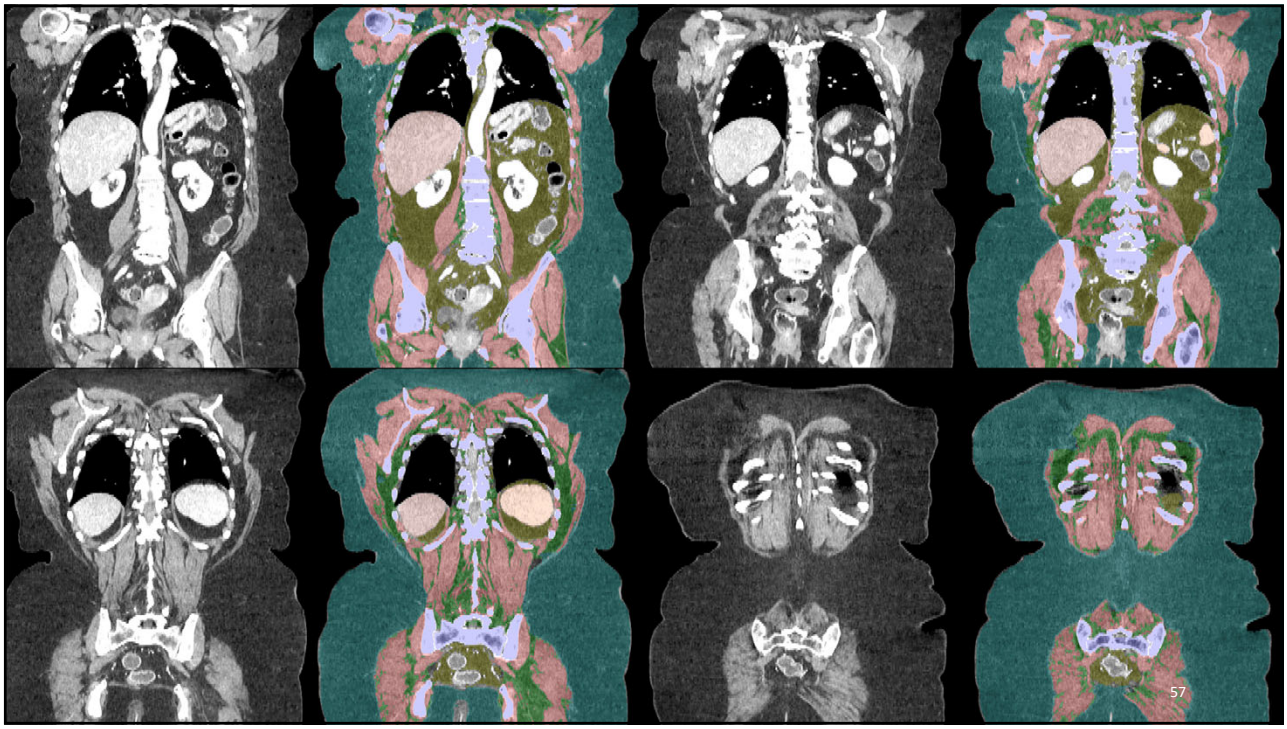


Skeletal Muscle

Adipose Tissue

Shen et al J Appl Physiol 97:2333, 2004

56



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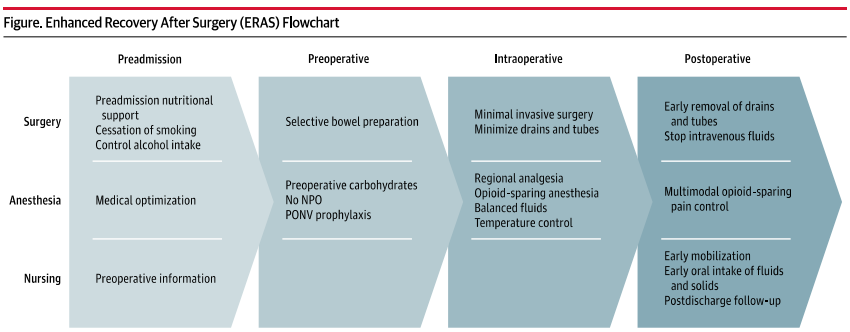
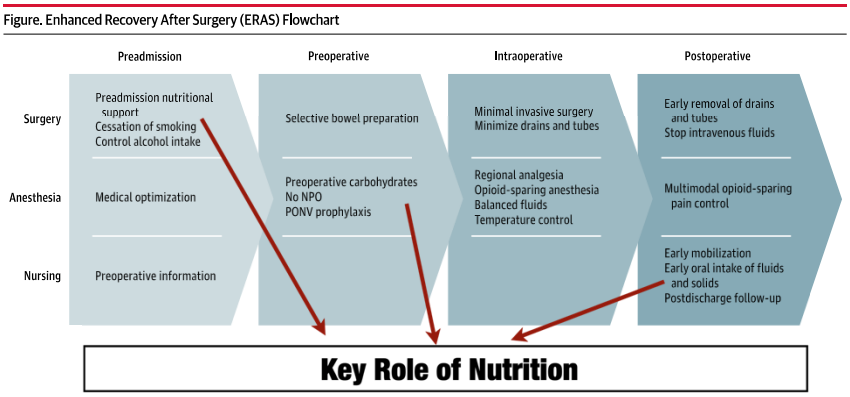


JAMA Surg. doi:10.1001/jamasurg.2016.4952 January 2017.

58



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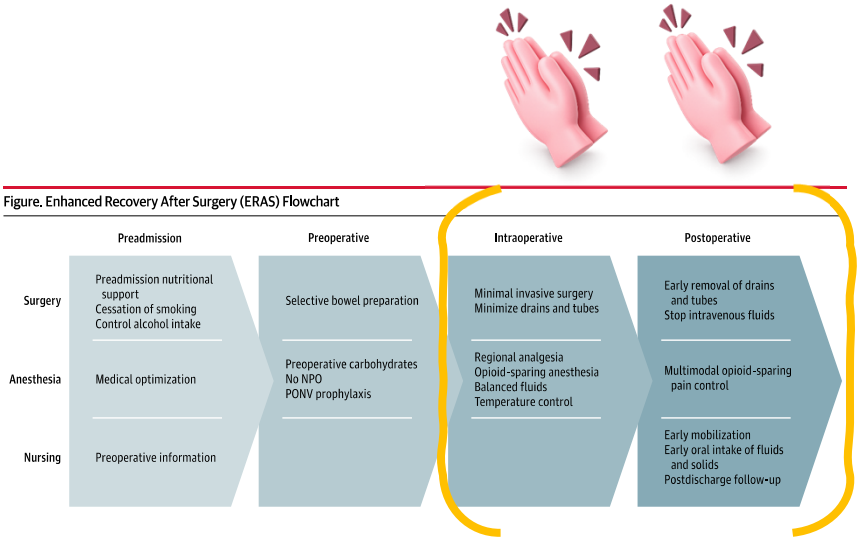

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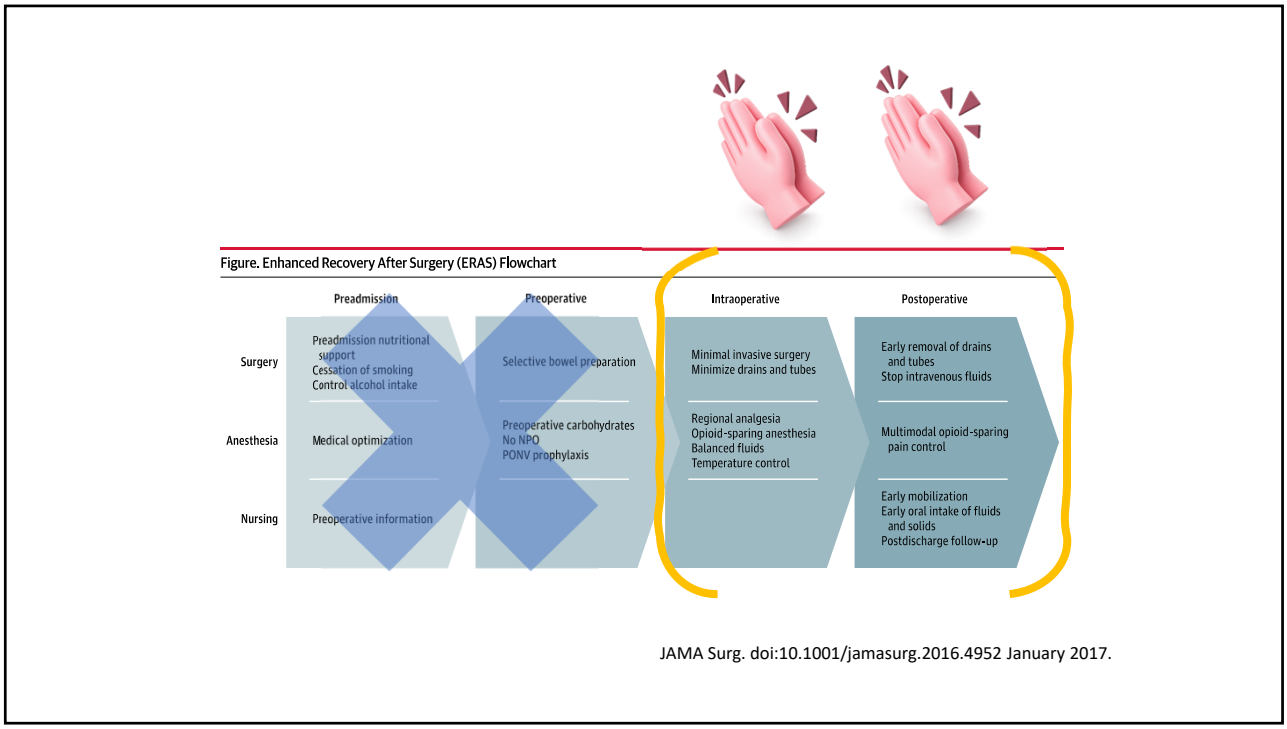

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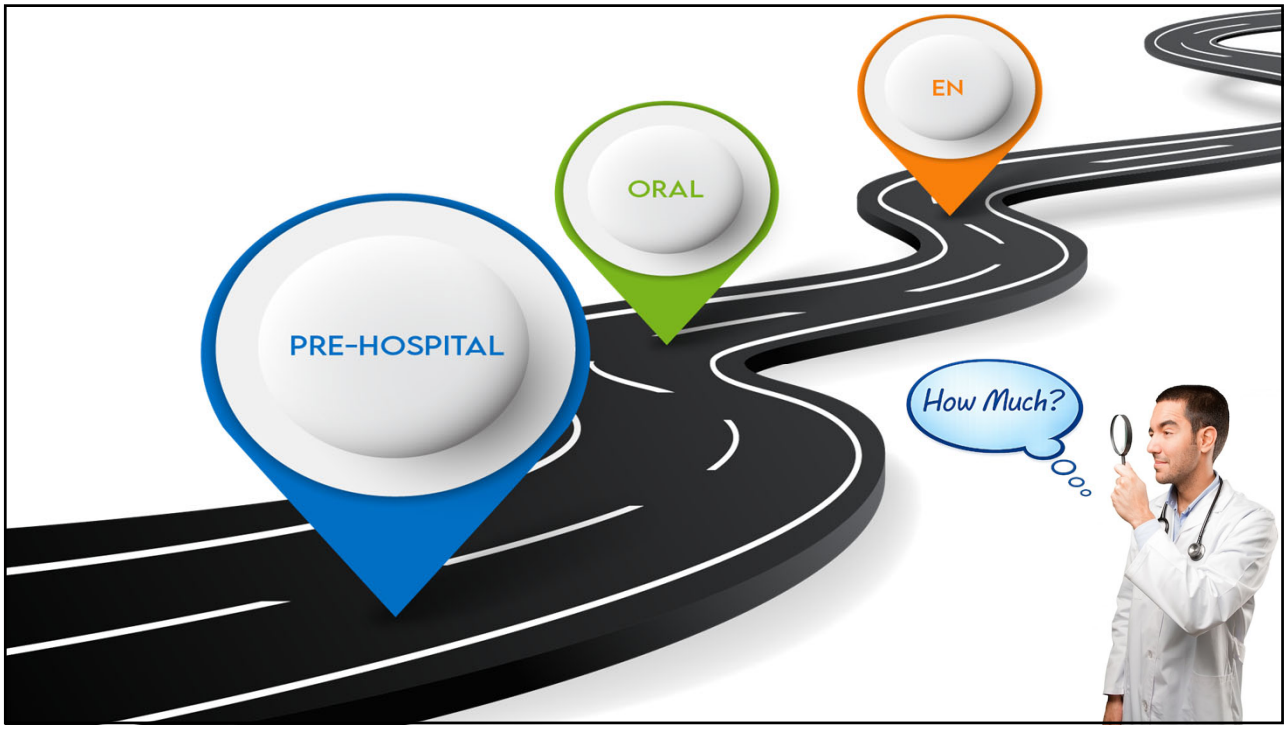
61



62

Clinical Nutrition xxx (2016) 1–12

Clinical Nutrition

journal homepage: www.elsevier.com/locate/clnu

REVIEW

Indirect calorimetry in nutritional therapy. A position paper by the ICALIC study group

Taku Oshima [a], Mette M. Berger [b], Elisabeth De Waele [c], Anne Berit Guttormsen [d,e,f], Claudia-Paula Heidegger [g], Michael Hiesmayr [h], Pierre Singer [i], Jan Wernerman [j], Claude Pichard [k,*]

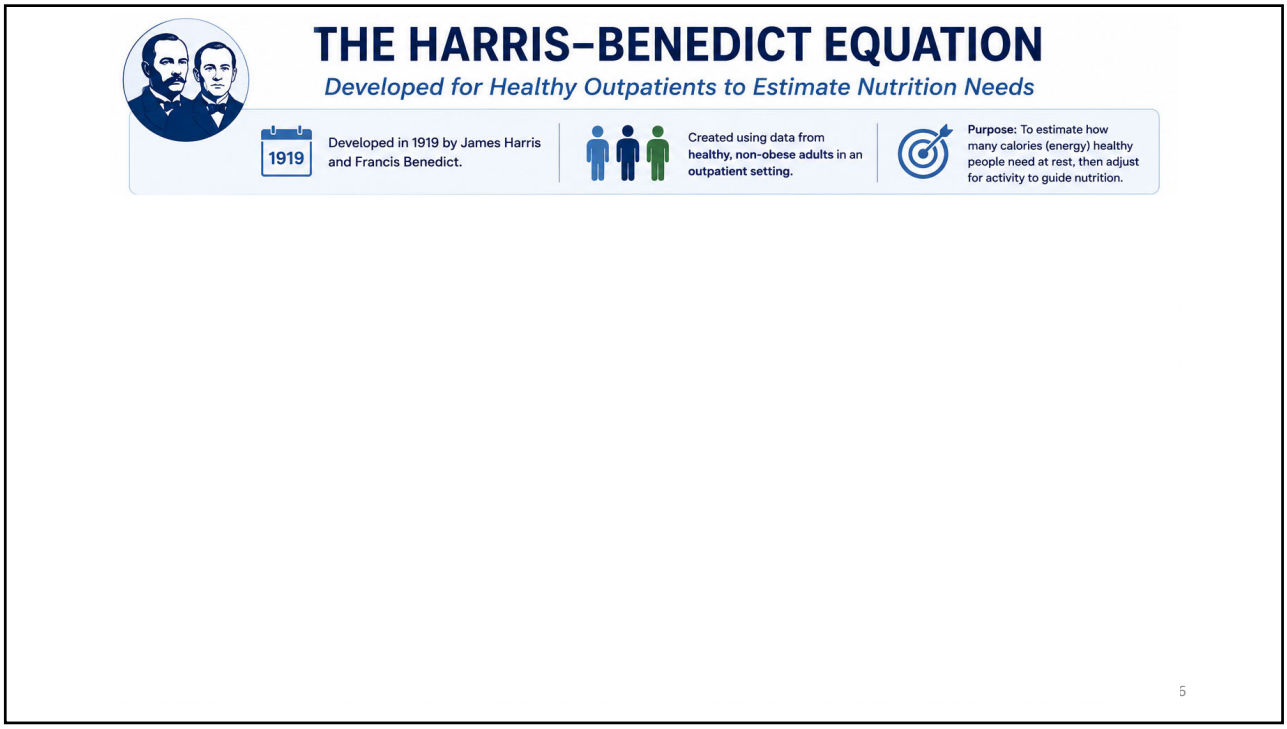
	INSUFFICIENT ENERGY INTAKE	EXCESSIVE ENERGY INTAKE
EARLY SIGNS	• Hypoglycemia • Hypothermia	• Hyperglycemia • Hyperlipidemia (triglycerides) • Hypercapnea
DELAYED SIGNS	• Infectious complications • Impaired immunity • Impaired healing • Loss of lean and fat body mass • Impaired muscle function	• Infectious complications • Impaired immunity • Liver steatosis • Increased fat mass

63

64


What should I use?

65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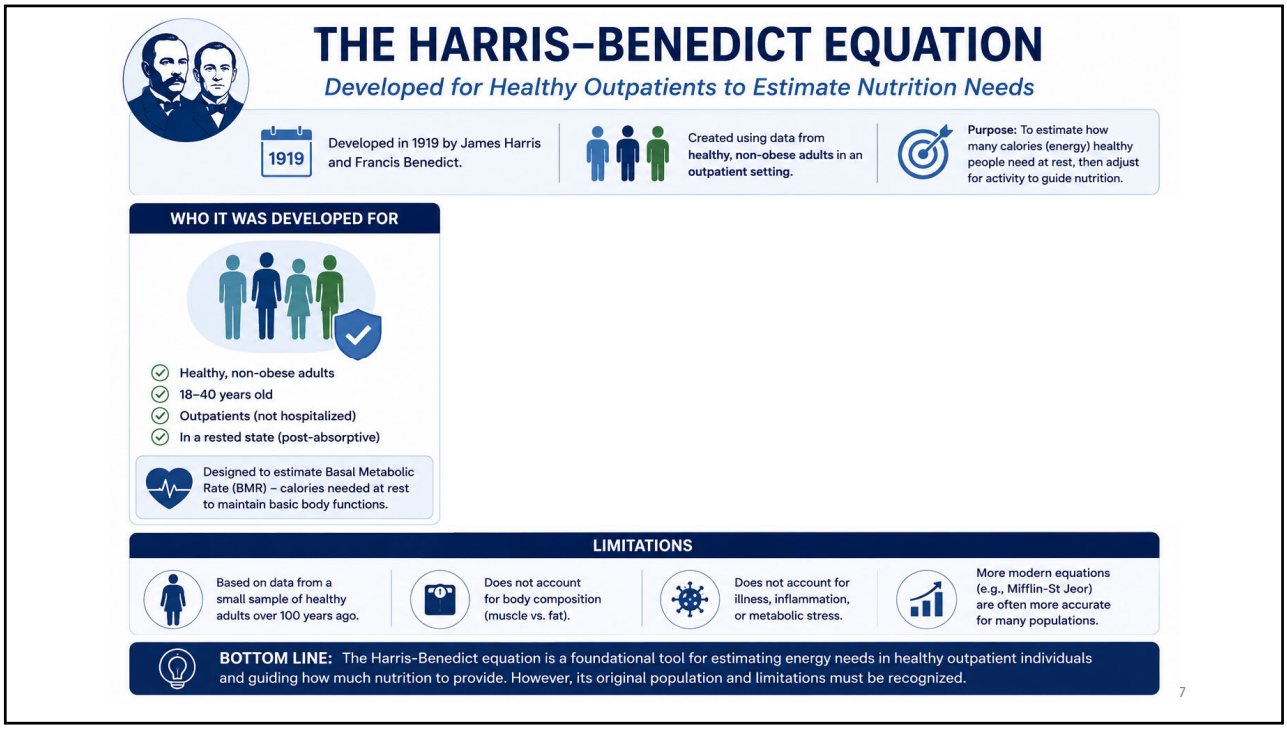
Developed for Healthy Outpatients to Estimate Nutrition Needs
1919
Developed in 1919 by James Harris and Francis Benedict.
Created using data from healthy, non-obese adults in an outpatient setting.
Purpose: To estimate how many calories (energy) healthy people need at rest, then adjust for activity to guide nutrition.
5

66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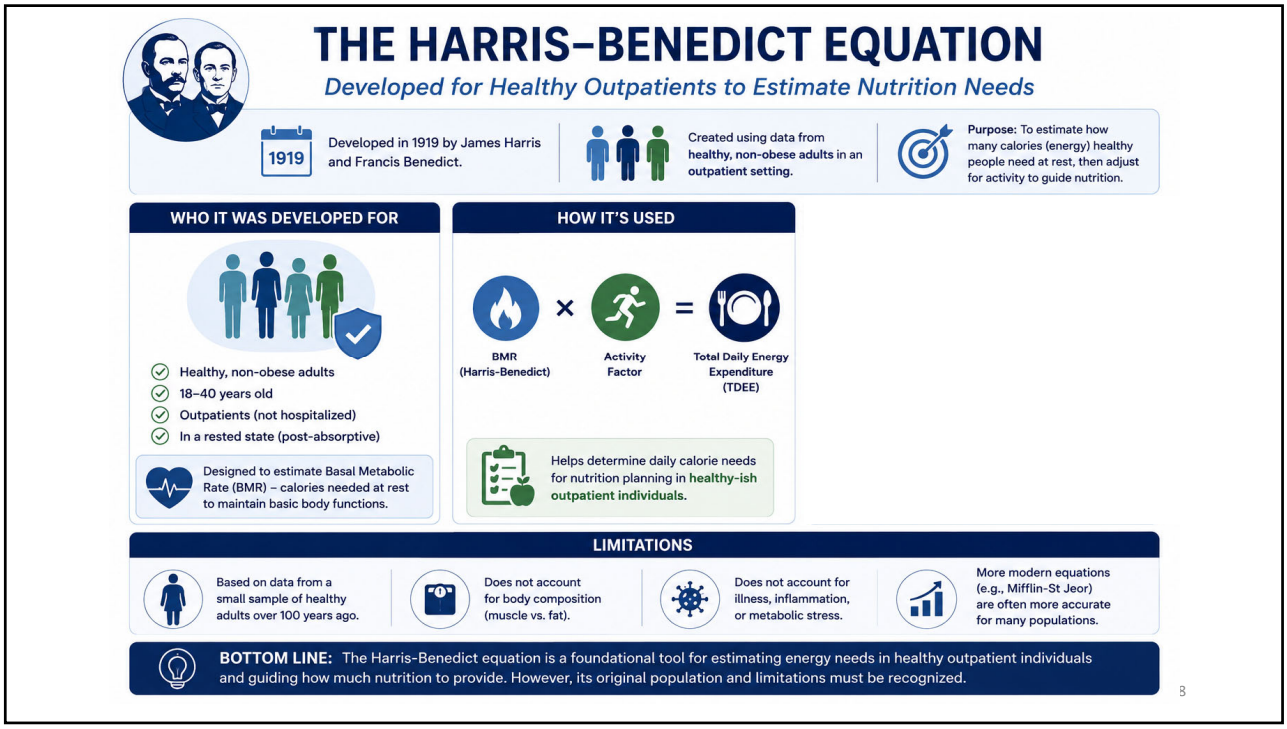
WHO IT WAS DEVELOPED FOR
Healthy, non-obese adults
18–40 years old
Outpatients (not hospitalized)
In a rested state (post-absorptive)
Designed to estimate Basal Metabolic Rate (BMR) – calories needed at rest to maintain basic body functions.
LIMITATIONS
Based on data from a small sample of healthy adults over 100 years ago.
Does not account for body composition (muscle vs. fat).
Does not account for illness, inflammation, or metabolic stress.
More modern equations (e.g., Mifflin-St Jeor) are often more accurate for many populations.
BOTTOM LINE: The Harris-Benedict equation is a foundational tool for estimating energy needs in healthy outpatient individuals and guiding how much nutrition to provide. However, its original population and limitations must be recognized.
7

67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WHO IT WAS DEVELOPED FOR
HOW IT'S USED
BMR (Harris-Benedict)
Activity Factor
Total Daily Energy Expenditure (TDEE)
Healthy, non-obese adults
18–40 years old
Outpatients (not hospitalized)
In a rested state (post-absorptive)
Designed to estimate Basal Metabolic Rate (BMR) – calories needed at rest to maintain basic body functions.
Helps determine daily calorie needs for nutrition planning in healthy-ish outpatient individuals.
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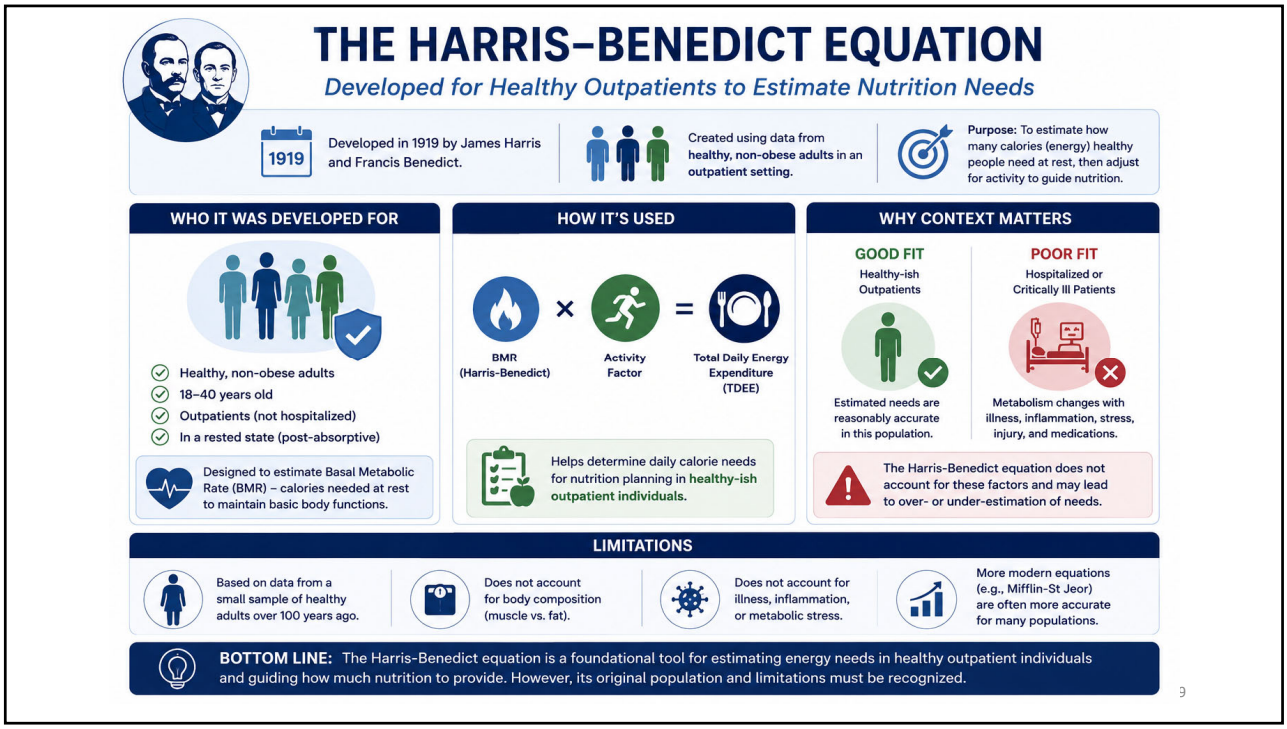
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Helps determine daily calorie needs for nutrition planning in healthy-ish outpatient individuals.
WHY CONTEXT MATTERS
GOOD FIT
Healthy-ish Outpatients
Estimated needs are reasonably accurate in this population.
POOR FIT
Hospitalized or Critically Ill Patients
Metabolism changes with illness, inflammation, stress, injury, and medications.
The Harris-Benedict equation does not account for these factors and may lead to over- or under-estimation of needs.
LIMITATIONS
Based on data from a small sample of healthy adults over 100 years ago.
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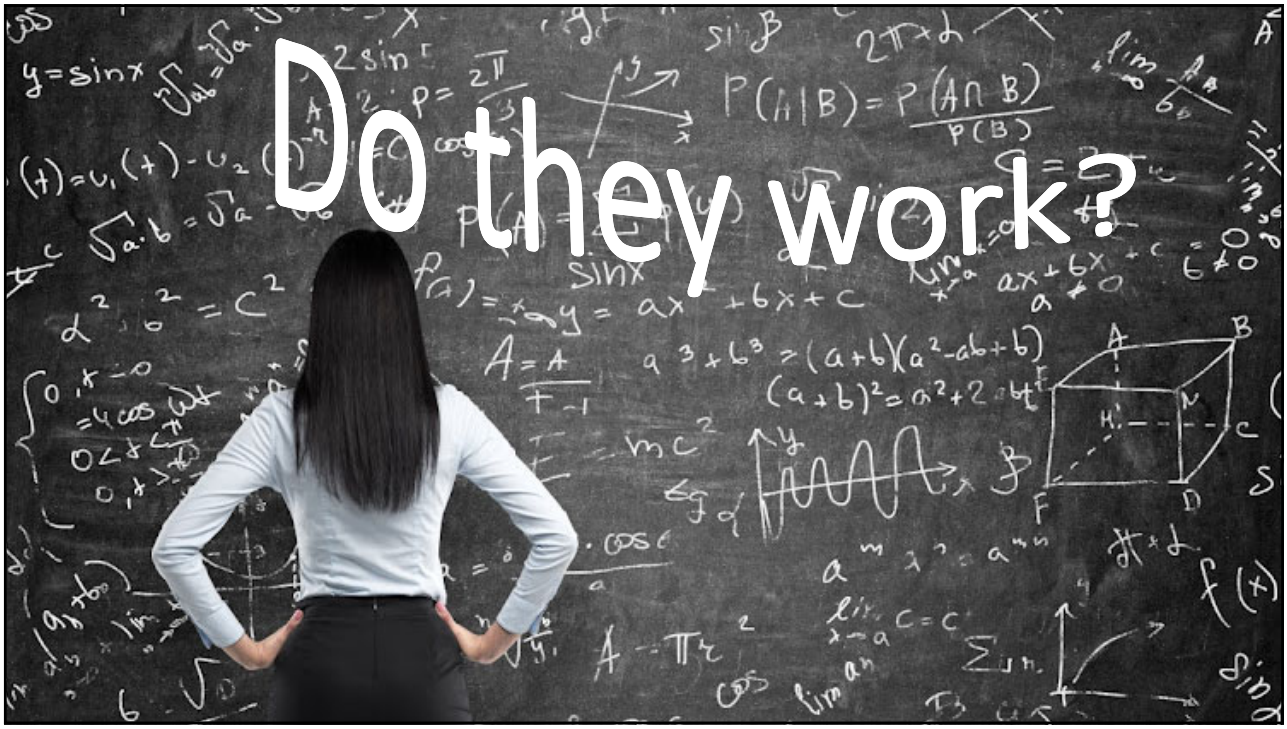
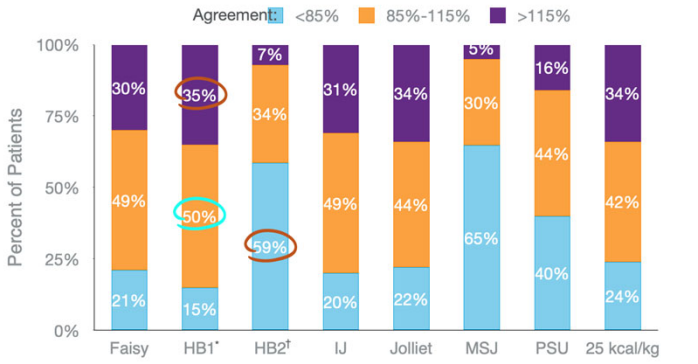

Do they work?

70

Predictive Equations Are Accurate < 50% of the Time!



Zusman O, et al. Clin Nutr. 2019;38:1206-1210.

71

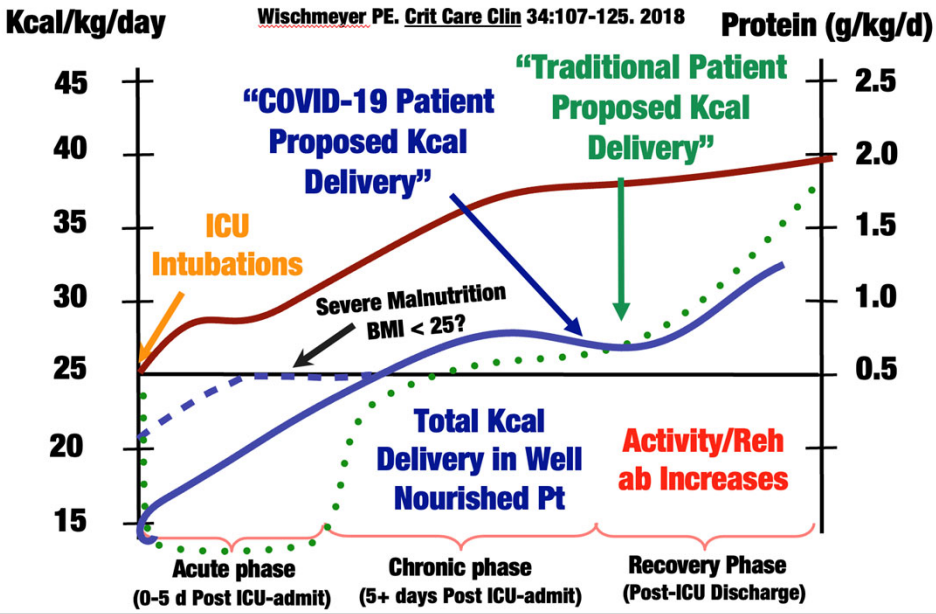
1/3 of Time You Are Overfeeding

1/3 of Time You Are Underfeeding

Zusman O, et al. Clin Nutr. 2019;38:1206-1210.

72

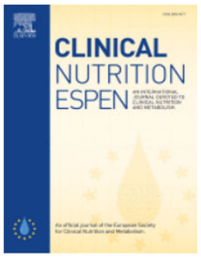
Targeted Nutrition Delivery in Critical Illness

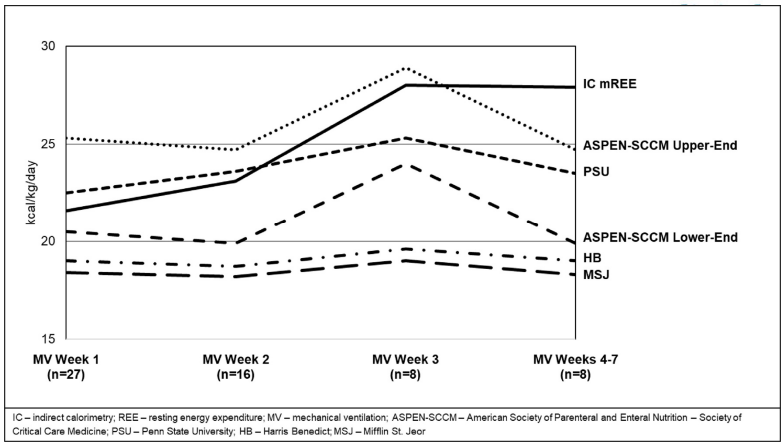


73

FULL TEXT ARTICLE

Prolonged progressive hypermetabolism during COVID-19 hospitalization undetected by common predictive energy equations

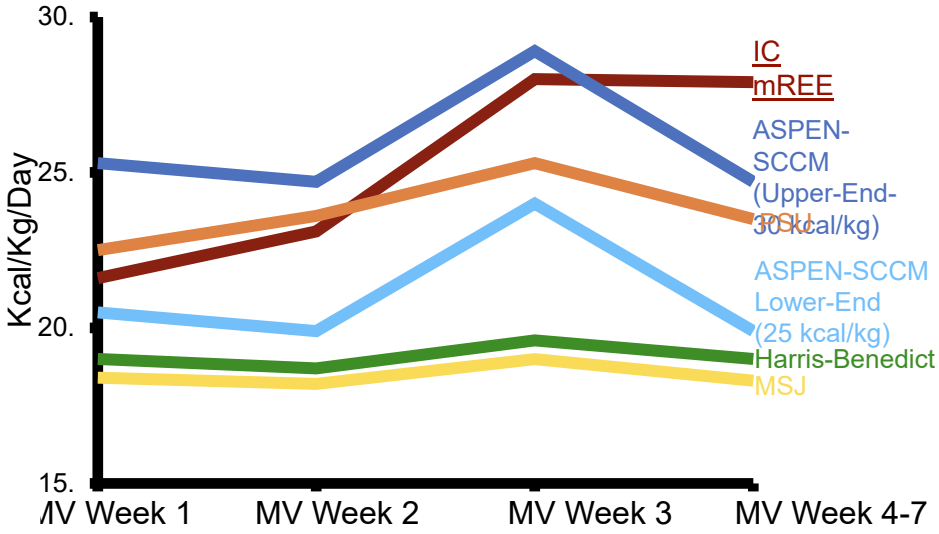




IC – indirect calorimetry; REE – resting energy expenditure; MV – mechanical ventilation; ASPEN-SCCM – American Society of Parenteral and Enteral Nutrition – Society of Critical Care Medicine; PSU – Penn State University; HB – Harris Benedict; MSJ – Mifflin St. Jeor

74

Measured REE Via Indirect Calorimetry Versus Commonly Used Predictive Equations in COVID-19 ICU Patients



75

IC in ESPEN COVID-19 Updates

ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection

March 24, 2020

2.2. Statement 2

… Energy needs can be assessed using indirect calorimetry if safely available with ensured sterility of the measurement system…

Indirect Calorimetry Can Be Done Safely in COVID-19 With Precautions!

ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection. March, 2020

x

76

77

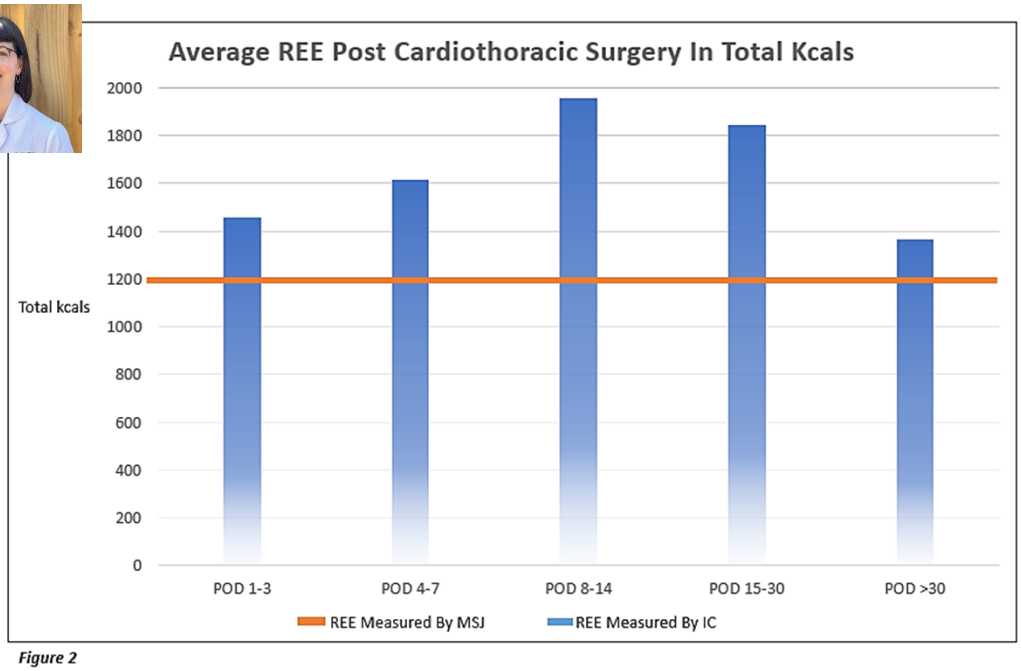
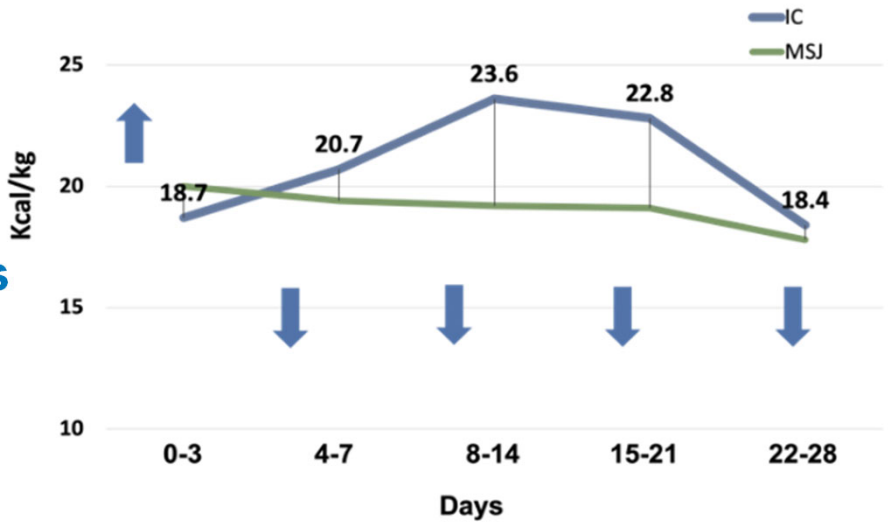


Figure 2
Average REE Post Cardiothoracic Surgery in **Total kcals**, comparing IC measurements to MSJ

78

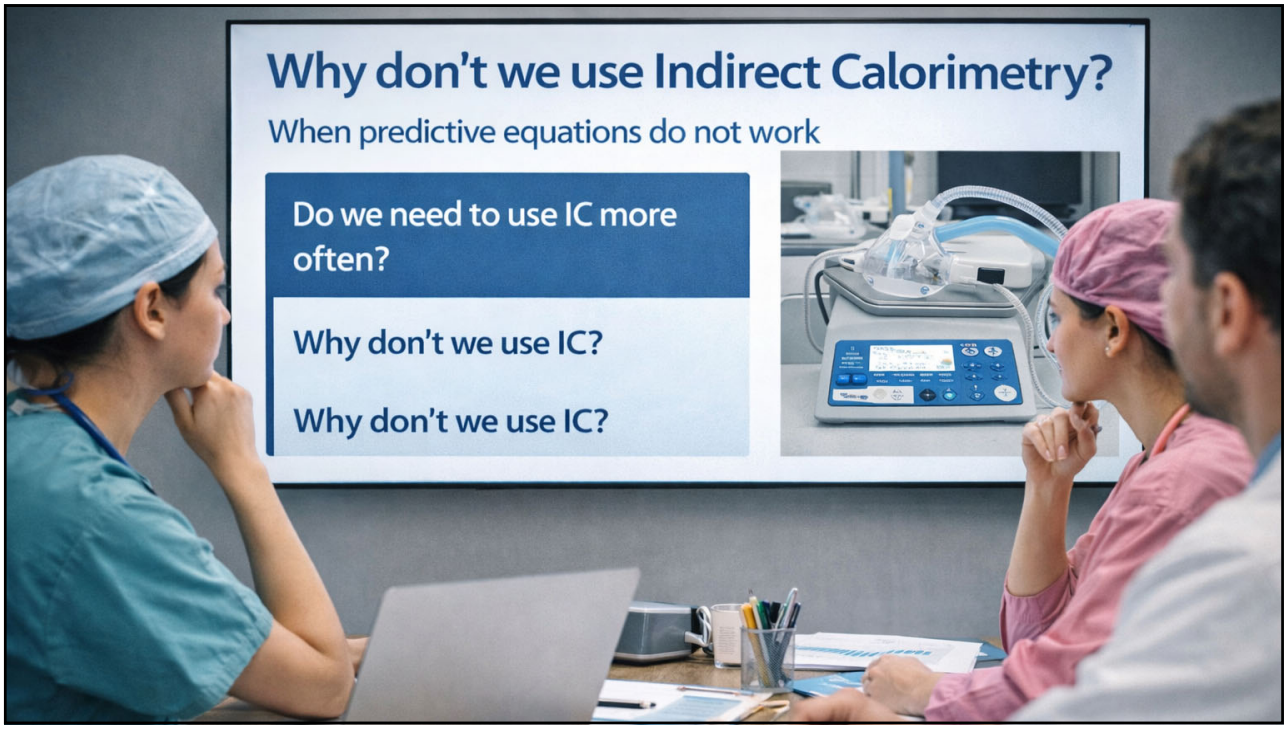
PASTDue ACS Patients

Open Abdomens



Mifflin St Jeor Over and Underpredicts REE through Hospital Discharge (ASPEN 2023)

79



80

81

ICU Nutrition Guidelines

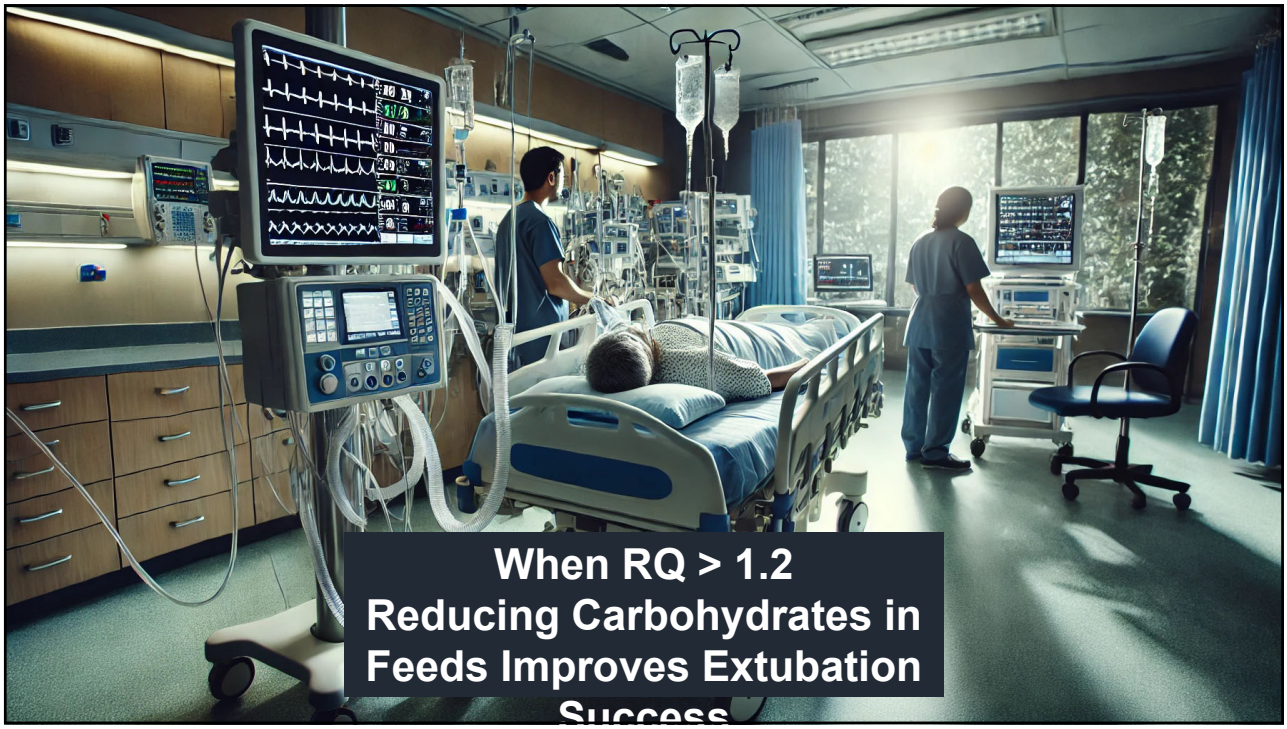
ESPEN
THE EUROPEAN SOCIETY FOR CLINICAL NUTRITION AND METABOLISM

Energy expenditure should be measured by indirect calorimetry

82


What else can Indirect Calorimetry do to Help Patients?

83


When RQ > 1.2
Reducing Carbohydrates in Feeds Improves Extubation Success

84


A LOT TO DO. ALL OF IT MATTERS.
Supporting Surgical Patients Through the Entire Journey
BETTER NUTRITION. BETTER RECOVERY.
BETTER OUTCOMES.
The right care at the right time
makes all the difference.

85


A LOT TO DO. ALL OF IT MATTERS.
Supporting Surgical Patients Through the Entire Journey
1. DIAGNOSIS
GLIM CRITERIA
MALNUTRITION IS DIAGNOSED
WHEN BOTH ARE PRESENT:
≥1
PHENOTYPIC
CRITERION
+
≥1
ETIOLOGIC
CRITERION
Identify at risk
and diagnose early
to improve outcomes.
BETTER NUTRITION. BETTER RECOVERY.
BETTER OUTCOMES.
The right care at the right time
makes all the difference.

86