NATIONAL QUALITY FORUM

National Voluntary Consensus Standards for Patient Outcomes
Measure Summary

Measure number: OT1-023-09

Measure name: Intensive Care Unit (ICU) Length-of-Stay (LOS)

Description: For all patients admitted to the ICU, total duration of time spent in the ICU until time of discharge; both observed and risk-adjusted LOS reported with the predicted LOS measured using a adjustment model based on the (Mortality Probability Model) MPM III

Numerator statement: For all eligible patients admitted to the ICU, the time at first discharge from ICU (either death or physical departure from the unit) minus the time of admission (first recorded vital sign on ICU flow sheet)

Denominator statement: Total number of eligible patients who are discharged (including deaths and transfers)

Level of Analysis: Clinicians: Group, Clinicians: Other Hospital and ICU

Type of Measure: Outcome

Data Source: paper medical record/flowsheet, Electronic clinical data

Measure developer: Philips R. Lee Institute

Type of Endorsement (full or time-limited): Recommended for Endorsement (Steering Committee – March 17, 2010 [Recommend-15, Do not Recommend – 2, Abstain-0])

Summary table of TAP ratings of sub criteria and comments:

IMPORTANCE TO MEASURE AND REPORT		
1a Impact	Completely	1a. Important hospital cost area; 1b - there is national data on variation in LOS; 1c. Outcome; How does availability of step or monitored beds affect the measure? Used in voluntary California program - CHART - reported by 246 hospitals (400 patients/year) of mostly community hospitals; flow issues from ED need to be addressed.
1b gap	Completely	
1c relation to outcomes	Completely	
SCIENTIFIC ACCEPTABILITY		
2a specs	Completely/ Partially	2a - P/C - only caveat is when to start ICU stay -- in the ED or PACU? What is the impact of the hospital infrastructure - could have a systematic bias is hospital structure limits moving patients in or out of ED or PACU - may affect comparability; this measure should be paired with the mortality measure; 2b solid reliability testing; 2c - validity testing of the model; reasonable exclusions; 2d. Risk Adjustment -- C=0.83 calibration curve; not yet publicly
2b reliability	Completely	
2c validity	Completely	
2d exclusions	Completely	
2e risk adjustment	Completely	

2f meaningful differences	Completely	reported in CHART; Disparities -- not included in risk factors -- not stratified though could be; Are there any racial differences in family/patient care goals or decisions?
2g comparability	Not applicable	
2h disparities	Not applicable	
USABILITY		
3a distinctive	Completely	Currently in use in California; plan for reporting in CHART; should be paired with mortality measure
3b harmonization	Not applicable	
3c Added value	Not applicable	
FEASIBILITY		
4a Data a by product of care	Minimally	4a - very compatible with EHRs - some vendors have built in; usually abstraction is used (reflects slow pace of EHR adoption); CHART has an electronic submission software also; 4d - trauma, burns, CBAG are excluded due to unique characteristics of these patients. First 100 patients per quarter data collection for ease.
4b Electronic	Completely	
4c Exclusions	Completely	
4d Inaccuracies	Completely	
4e Implementation	Completely	

Summary table of SC ratings of sub criteria and comments:

IMPORTANCE TO MEASURE AND REPORT	
TAP and SC members agreed the measure is an important outcome, with variation in care and opportunity for improvement.	SC Vote on Importance Yes - 17 No - 0
SCIENTIFIC ACCEPTABILITY	
The TAP rated this measure as high under scientific acceptability; it has a publicly available risk model that has been used and improved on for several years. The SC discussed issues around identifying the time of onset, particularly patients coming from the emergency department and post-operative care and how patients are moved through different levels of care. There were concerns that this measure would not capture readmission to the hospital. In the future this should be looked at, cannot be done in a short time frame. SC Members were extremely interested in how disparities might be handled as cultural aspects could affect LOS. The developer noted that data for SES, race and ethnicity are generally not	SC vote on scientific acceptability Completely -11 Partially – 7 Minimally – 0 Not at all – 0

available. SC Members suggested insurance type might be one proxy. The SC encouraged the measure developers to think of ways to gather this information for future measures.	
USABILITY	
Currently, this measure is being used in California by hospitals and plans to be included in public reporting. In response to a question, the measure developer explained that teaching status doesn't have much of an impact- the higher predictive mortality rates the risk seems to be captured through this model. Additional data from outside California would be helpful. An SC member asked "Do clinicians who get the feedback believe that the measure distinguishes good care or overuse of care, or do providers who are expected to have good care appear to look good with this measure?" The goal is to match the clinical outcome with a utilization outcomes and the LOS measure and mortality measures should be endorsed together as they both support each other Some SC Members indicated a strong preference for stratification by race/ethnicity or SES	SC vote on usability Completely – 14 Partially – 3 Minimally – 0 Not at all – 0
FEASIBILITY	
This measure is very compatible with EHRs. AN SC member noted that the measure requires significant data abstraction even with electronic records and is therefore labor intensive which decreases usability and feasibility when it is to be reported on 400 patients each year.	SC vote on feasibility Completely – 13 Partially – 4 Minimally -0 Not at all -0

Summary table of Biostatistical Review:

Type of Risk Model : *Linear regression.*
RISK FACTORS

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Are the risk factors clearly identified in the submission information? *YES*
Does the model include risk factors associated with differences/inequalities with care such as race, socioeconomic status or gender? *NO*
Are the conceptual and quantitative criteria for inclusion or exclusion or combining of risk factors explained and appropriate? *YES.* *(See review of OT1-024-09 for comments.)*
Is quantitative assessment of the relative contribution of the model components described in detail? *It is not described directly, but can be obtained (more or less) from the information provided in the article..*
Does the measure have exclusions that influence outcomes that should be included as risk factors? *NO*
Comments on risk factors: *See review of OT1-024-09.*
VALIDATION OF THE RISK MODEL Is there information provided on the cross-validation of the model comparing a development sample and a validation sample provided? *YES* Is there information on independent, external validation of the model in another data set? *NO* Are the results supportive of a valid model? *YES.*
RISK MODEL PERFORMANCE (2e)
DISCRIMINATION: R-squared = 0.098. At the hospital level, approximately 27.9% of the between hospital variation in average LOS was explained by the model. Does the statistic support good discrimination? *Yes. The model appears to capture less variation than a model based on APACHE IV. However, the APACHE-IV model uses information collected during the first 24-hours of ICU admission instead of the 1st hour. For risk adjusting hospital comparisons, a 1-hour time interval is more appropriate.*
CALIBRATION: Is a calibration curve included? YES

Is a risk decile plot included? Can be obtained from calibration plot.
Hosmer-Lemeshow statistic:

N/A. Goodness of fit was tested using t-tests comparing observed vs. predicted in each decile and in subgroups.

Does the data support good model calibration?

YES. There were some departures from perfect fit in certain subgroups but overall fit was reasonable.

Comments on Risk Model Performance:

The risk model was obtained by using predictors from the MPM0-III mortality mode. Coefficients were re-estimated for the endpoint of LOS. It would be interesting to know how the resulting model would compare to a similar model derived from SAPS-III.

Reliability testing (2b):
Is the reliability of the key data elements, such as risk factors and the outcome demonstrated?

Yes. See review of OT1-024-09.

Is there information about the reliability of the measure score, such as signal to noise ratio?

Yes. A caterpillar plot was provided which illustrates substantial between-hospital variation in performance with enough precision to detect several outliers.

Has a sensitivity analysis been performed for problem or missing data?

NO. More information would be useful.

Does the data demonstrate that the risk model is reliable? *YES*

Comments on reliability testing:

See review of OT1-024-09.

Validity testing (2c):

Is validity testing of the measure to demonstrate results can be used to make conclusions about quality provided?

Yes. Validity testing focused on assessing the fit of the risk model.

Are the results supportive of a valid measure?

Yes, with caveats.

Comments on validity testing:

See review of OT1-024-09.

Scoring Method Justification (2f):

Is the choice of method for computing risk-adjusted scores and identifying statistically significant differences justified? YES.

Comments on scoring methods:

The measure is based on comparing observed vs. predicted average LOS. To reduce sensitivity to outliers (very long stays), stays longer than 30 days are counted as 30 days. This seems very reasonable.

Summary comments:

The analytic methods and documentation were generally excellent. Possible issues include: a) comparison to SAP-III, b) handling of missing data.

Reviewer: Sean O'Brien, PhD
Assistant Professor, Department of Biostatistics and Bioinformatics
Duke University Medical Center, Duke Clinical Research Institute,
Durham, NC

Attachments: None

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Measure Evaluation 4.1
December 2009

This form contains the measure information submitted by stewards. Blank fields indicate no information was provided. Attachments also may have been submitted and are provided to reviewers. The subcriteria and most of the footnotes from the evaluation criteria are provided in Word comments within the form and will appear if your cursor is over the highlighted area. Hyperlinks to the evaluation criteria and ratings are provided in each section.

TAP/Workgroup (if utilized)**:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met. Based on your evaluation, summarize the strengths and weaknesses in each section.

Note: *If there is no TAP or workgroup, the SC also evaluates the subcriteria (yellow highlighted areas).*

Steering Committee: Complete all pink highlighted areas of the form. Review the workgroup/TAP assessment of the subcriteria, noting any areas of disagreement; then evaluate the extent to which each major criterion is met; and finally, indicate your recommendation for the endorsement. Provide the rationale for your ratings.

Evaluation ratings of the extent to which the criteria are met
C = Completely (unquestionably demonstrated to meet the criterion)
P = Partially (demonstrated to partially meet the criterion)
M = Minimally (addressed BUT demonstrated to only minimally meet the criterion)
N = Not at all (NOT addressed; OR incorrectly addressed; OR demonstrated to NOT meet the criterion)
NA = Not applicable (only an option for a few subcriteria as indicated)

(for NQF staff use) **NQF Review #:** OT1-023-09 **NQF Project:** Patient Outcomes Measures: Phases I and II
MEASURE DESCRIPTIVE INFORMATION
De.1 **Measure Title:** Intensive Care Unit (ICU) Length-of-Stay (LOS)
De.2 **Brief description of measure:** For all patients admitted to the ICU, total duration of time spent in the ICU until time of discharge; both observed and risk-adjusted LOS reported with the predicted LOS measured using a adjustment model based on the (Mortality Probability Model) MPM III
1.1-2 **Type of Measure:** Outcome De.3 **If included in a composite or paired with another measure, please identify composite or paired measure**
De.4 **National Priority Partners Priority Area:** Overuse De.5 **IOM Quality Domain**: Efficiency De.6 **Consumer Care Need:** Staying healthy

CONDITIONS FOR CONSIDERATION BY NQF	
Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:	NQF Staff
A. The measure is in the public domain or an intellectual property (measure steward agreement) is signed. *Public domain only applies to governmental organizations. All non-government organizations must sign a measure steward agreement even if measures are made publicly and freely available.* A.1 **Do you attest that the measure steward holds intellectual property rights to the measure and the right to use aspects of the measure owned by another entity (e.g., risk model, code set)?** Yes A.2 **Indicate if Proprietary Measure** (*as defined in measure steward agreement*)**:** A.3 **Measure Steward Agreement:** Agreement will be signed and submitted prior to or at the time of measure submission A.4 **Measure Steward Agreement attached:**	**A** Y☒ N☐
B. The measure owner/steward verifies there is an identified responsible entity and process to maintain and	**B**

update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. Yes, information provided in contact section	Y☒ N☐
C. The intended use of the measure includes both public reporting and quality improvement. ►**Purpose:** Public reporting, Internal quality improvement	**C** Y☒ N☐
D. The requested measure submission information is complete. Generally, measures should be fully developed and tested so that all the evaluation criteria have been addressed and information needed to evaluate the measure is provided. Measures that have not been tested are only potentially eligible for a time-limited endorsement and in that case, measure owners must verify that testing will be completed within 12 months of endorsement. D.1**Testing:** Yes, fully developed and tested D.2 **Have NQF-endorsed measures been reviewed to identify if there are similar or related measures?** Yes	**D** Y☒ N☐
(for NQF staff use) **Have all conditions for consideration been met?** **Staff Notes to Steward** (*if submission returned*)**:**	**Met** Y☐ N☐
Staff Notes to Reviewers (*issues or questions regarding any criteria*)**:**	
Staff Reviewer Name(s): Alexis Forman	

TAP/Workgroup Reviewer Name:	
Steering Committee Reviewer Name:	
1. IMPORTANCE TO MEASURE AND REPORT	
Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes for a specific high impact aspect of healthcare where there is variation in or overall poor performance. ***Measures must be judged to be important to measure and report*** *in order to be evaluated against the remaining criteria.* (evaluation criteria) **1a. High Impact**	Eval Rating
(for NQF staff use) Specific NPP goal: Not related to a specific NPP goal.	
1a.1 **Demonstrated High Impact Aspect of Healthcare:** High resource use, Affects large numbers, Frequently performed procedure, Leading cause of morbidity/mortality, Patient/societal consequences of poor quality, Severity of illness 1a.2 1a.3 **Summary of Evidence of High Impact:** ICU resource use is viewed as as key indicator in assessing ICU performance. However, cost data are rather difficult to collect. ICU LOS, however, has become a surrogate for cost due to its relatively easy definability and measurability. One study even reported that length of stay statistically explains approximately 85 to 90% of interpatient variation in hospital costs. By 2005, critical care costs in the US were estimated to be $81.7 billion accounting for 13.4% of hospital costs, 4.1% of the national health expenditures and 0.66% of the gross domestic product. With mean estimated ICU costs estimated to be greater than $30,000 (when patients are mechanically ventilated) and initial ICU days found to be four times as costly as initial non-ICU hospital days, reductions in ICU LOS are viewed as a potential target for cost-cutting efforts. 1a.4 **Citations for Evidence of High Impact:** Dasta JF, McLaughlin TP et al. Daily cost of an intensive care unit day: the contribution of mechanical ventilation. Crit Care Med 2005 Jun;33(6):1266-71. Halpern NA. Can the costs of critical care be controlled? Curr Opin Crit Care 2009 Oct 9. [Epub ahead of print] Rapoport JTD, Zhao Y, Lemeshow S. Length of stay data as a guide to hospital economic performance for	**1a** C☒ P☐ M☐ N☐

ICU patients. Medical Care 2003;41:386-97.
Rosenberg AL, Zimmerman JE, Alzola C et al. Intensive care unit length of stay: recent changes and future challenges. Crit Care Med 2000 Oct 28(10):3465-73.

1b. Opportunity for Improvement

1b.1 Benefits (improvements in quality) envisioned by use of this measure:

1b.2 Summary of data demonstrating performance gap (variation or overall poor performance) across providers:
Just as in-hospital mortality variation following ICU admission has been well-documented in the literature, so has variation in ICU LOS. One of the earlier publications on this subject (1993) in 42 ICUs among 40 volunteer hospitals reported a mean unadjusted length of ICU stay varying from 3.3 to 7.3 days, with 78% of the variation attributable to patient and selected institutional characteristics. More recent studies on different patient populations have since documented similar variation in ICU resource use and have made efforts to uncover reasons for this variability. Hospital geographic location has been interestingly found to be a significant contributor to ICU LOS in certain situations, though other structural and/or procedural variables are targets of further review.

1b.3 Citations for data on performance gap:
Keenan SP, Dodek P, Martin C et al. Variation in length of intensive care unit stay after cardiac arrest: where you are is as important as who you are. Crit Care Med 2007;35:836-41.
Knaus WA, Wagner DP, et al. Variations in mortality and length of stay in intensive care units. Ann Int Med 1993;118:753-61.
Render ML, Kim M, Deddens J et al. Variation in outcomes in Veterans Affairs intensive care units with a computerized severity measure. Crit Care Med 2005;33(5): 930-9.
Rothen HU, Stricker K, Einfalt E et al. Variability in outcome and resource use in intensive care units. Intensive Care Med 2007;33:1329-36.
Vasilevskis EE, Kuzniewicz MW et al. Mortality Probability Model III and Simplified Acute Physiology Score II: assessing their value in predicting length of stay and comparison to APACHE IV. Chest 2009 Jul;136(1):89-101.

1b.4 Summary of Data on disparities by population group:
Disparities in ICU LOS do exist among different population groups. In an Italian study of patients with any of the following diagnoses - trauma, brain-trauma, brain-hemorrhage, stroke, acute-on-chronic-obstructive-pulmonary disease, lung-injury/acute respiratory distress syndrome, heart failure, and scheduled/unscheduled abdominal surgery - mean ICU variable-costs (and associated LOS) significantly differed with diagnosis and level-of-care. Other studies have documented higher costs per day in other diagnostic groups, such as septic patients or multiple trauma patients. In addition, racial disparity in LOS has even been reported for African-Americans, whose adjusted ICU length of stay was significantly shorter than that of whites.

1b.5 Citations for data on Disparities:
Iapichino G, Radrizzani D et al. Effectiveness and efficiency of intensive care medicine: variable costs in different diagnostic groups. Acta Anaesthesiol Scand 2004 Aug;48(7):820-6.
Moerer O, Plock E, Mgbor U et al. A German national prevalence study on the cost of intensive care: an evaluation from 51 intensive care units. Crit Care 2007;11(3):R69.
Rossi C, Simini B, Brazzi L et al. Variable costs of ICU patients: a multicenter prospective study. Intensive Care Med 2006 Apr;32(4):545-52.
Williams JF, Zimmerman JE et al. African-American and white patients admitted to the intensive care unit: is there a difference in therapy and outcome? Crit Care Med 1995 Apr;23(4):626-36.

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1c. Outcome or Evidence to Support Measure Focus

1c.1 Relationship to Outcomes (*For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population*)**:** The length-of-stay of

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hospitalized patients has been demonstrated to be a contributor to cost. Nowhere is this more evident than in the intensive care unit, where the severity of illness requires costly technology to support such critically ill patients. The efficiency of ICU resource use along with overall quality of care can be measured as a means to compare performance between hospitals. Using the LOS measure, the hope is to identify modifiable factors enabling improvement in both ICU efficiency and effectiveness. **1c.2-3. Type of Evidence:** Observational study, Systematic synthesis of research **1c.4 Summary of Evidence** (*as described in the criteria; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome*)**:** A 2007 analysis using the SAPS 3 database found that the presence of interprofessional rounds and an on-site emergency department were both factors that contributed to performance categorization of a hospital based on its risk-adjusted mortality and risk-adjusted LOS. A number of studies have also looked at intensivist staffing as a means of successfully reducing both ICU and hospital LOS. Adherence to process measures such as stress ulcer prophylaxis, deep vein thrombosis prophylaxis, appropriate use of transfusions, and appropriate sedation have also been reviewed in the literature in an effort to shorten ICU LOS. These are but a few of the potential structural features or care processes that may be influential in reducing the LOS outcome. **1c.5 Rating of strength/quality of evidence (***also provide narrative description of the rating and by whom***):** Not-applicable **1c.6 Method for rating evidence:** Not-applicable **1c.7 Summary of Controversy/Contradictory Evidence:** A recent study published in 2008 attempted to estimate the actual cost savings that could be achieved through reductions in ICU LOS and duration of mechanical ventilation by determining the short-run marginal variable cost of an ICU and ventilator day. Interestingly, authors found that marginal direct-variable costs (the cost of each additional ICU day) were small compared with the average daily total cost. Consequently, reducing ICU and hospital LOS by 1 day in all survivors with ICU LOS more than 3 days would result in an immediate cost savings of only 0.2% of all hospital expenditures for these patients. This potential lack of association between clinical and economic quality indicators requires further examination. **1c.8 Citations for Evidence (***other than guidelines***):** Kahn JM, Rubenfeld GD et al. Cost savings attributable to reductions in intensive care unit length of stay for mechanically ventilated patients. Med Care 2008 Dec;46(12):1226-33. Niskanen M, Reinikainen M, Pettilä V. Case-mix-adjusted length of stay and mortality in 23 Finnish ICUs. Intensive Care Med 2009 Jun;35(6):1060-7. Pronovost PJ, Angus DC et al. Physician staffing patterns and clinical outcomes in critically ill patients: a systematic review. JAMA 2002 Nov 6;288(17):2151-62. Rothen HU, Stricker K, Einfalt E et al. Variability in outcome and resource use in intensive care units. Intensive Care Med 2007;33:1329-36. **1c.9 Quote the Specific guideline recommendation (***including guideline number and/or page number***):** Not-applicable **1c.10 Clinical Practice Guideline Citation:** Not-applicable **1c.11 National Guideline Clearinghouse or other URL:** Not-applicable **1c.12 Rating of strength of recommendation (***also provide narrative description of the rating and by whom***):** Not-applicable **1c.13 Method for rating strength of recommendation** (*If different from* USPSTF system*, also describe rating and how it relates to USPSTF)***:** Not-applicable	**N☐**

1c.14 **Rationale for using this guideline over others:** Not-applicable	
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Importance to Measure and Report?* 1a. Important hospital cost area; 1b - there is national data on variation in LOS; 1c. Outcome; How does availability of step or monitored beds affect the measure? Used in voluntary California program - CHART - reported by 246 hospitals (400 patients/year) of mostly community hospitals; flow issues from ED need to be addressed.	**1**
Steering Committee: Was the threshold criterion, *Importance to Measure and Report*, met? **Rationale:** The Pulmonary/ICU TAP rated this measure highly and recommended that it be paired with the ICU mortality measure to address potential premature discharge from the ICU that harms patients. This measure will be publicly reported on www.CalHospitalCompare.org. • TAP and SC members agreed the measure is an important outcome, with variation in care and opportunity for improvement.	**1** **Y**☒ **N**☐
2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES	
Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented. (evaluation criteria)	Eval Rating
2a. MEASURE SPECIFICATIONS	
S.1 **Do you have a web page where current detailed measure specifications can be obtained?** S.2 **If yes, provide web page URL:** **2a. Precisely Specified**	
2a.1 **Numerator Statement (***Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome***):** For all eligible patients admitted to the ICU, the time at discharge from ICU (either death or physical departure from the unit) minus the time of admission (first recorded vital sign on ICU flow sheet) 2a.2 **Numerator Time Window (***The time period in which cases are eligible for inclusion in the numerator***):** Not-applicable; Anyone with an ICU admission meeting eligibility criteria below is in the numerator. 2a.3 **Numerator Details (***All information required to collect/calculate the numerator, including all codes, logic, and definitions***):** Eligible patients include those with an ICU stay of at least 4 hours and >18 years of age whose primary reason for admission does not include trauma, burns, or immediately post-coronary artery bypass graft surgery (CABG), as these patient groups are known to require unique risk-adjustment. Only index (initial) ICU admissions are recorded given that patient characteristics of readmissions are known to differ.	
2a.4 **Denominator Statement (***Brief, text description of the denominator - target population being measured***):** Total number of eligible patients who are discharged (including deaths and transfers) 2a.5 **Target population gender:** Female, Male 2a.6 **Target population age range:** >18 years of age 2a.7 **Denominator Time Window (***The time period in which cases are eligible for inclusion in the denominator***):** Not-applicable; Anyone with an ICU admission meeting eligibility criteria below is in the denominator. 2a.8 **Denominator Details (***All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions***):** Eligible patients include those with an ICU stay of at least 4 hours and >18 years of age whose primary reason for admission does not include trauma, burns, or immediately post-coronary artery bypass graft	**2a-specs** **C**☒ **P**☐ **M**☐ **N**☐

surgery (CABG), as these patient groups are known to require unique risk-adjustment. Only index (initial) ICU admissions are recorded given that patient characteristics of readmissions are known to differ.

2a.9 **Denominator Exclusions (***Brief text description of exclusions from the target population***):** <18 years of age at time of ICU admission, ICU readmission, <4 hours in ICU, primary admission due to trauma, burns, or immediately post-CABG, admitted to exclude myocardial infarction (MI) and subsequently found without MI or any other acute process requiring ICU care

2a.10 **Denominator Exclusion Details (***All information required to collect exclusions to the denominator, including all codes, logic, and definitions***):**
<18 years of age at time of ICU admission (with time of ICU admission abstracted preferably from ICU vital signs flowsheet), ICU readmission (i.e. not the patient's first ICU admission during the current hospitalization), <4 hours in ICU, primary admission due to trauma, burns, or immediately post-CABG, admitted to exclude myocardial infarction (MI) and subsequently found without MI or any other acute process requiring ICU care

2a.11 **Stratification Details/Variables (***All information required to stratify the measure including the stratification variables, all codes, logic, and definitions***):**
Not-applicable

2a.12-13 **Risk Adjustment Type:**

2a.14 **Risk Adjustment Methodology/Variables (***List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method***):**
Risk-adjustment variables include: age, heart rate >=150, SBP <=90, chronic renal, acute renal, GIB, cardiac arrhythmia, intracranial mass effect, mechanical ventilation, received CPR, cancer, cerebrovascular incident, cirrhosis, coma, status post elective surgery, zero factor status (no risk factors other than age), and full code status (no restrictions on therapies or interventions at the time of ICU admission). The LOS risk-adjustment model is based on the MPM III (mortality probability model) with coefficients customized for the population of interest.

2a.15-17 **Detailed risk model available Web page URL or attachment:** Attachment MPMIII LOS Model.pdf

2a.18-19 **Type of Score:** Rate/proportion
2a.20 **Interpretation of Score:**
2a.21 **Calculation Algorithm (***Describe the calculation of the measure as a flowchart or series of steps***):**
The hospital's mean observed ICU LOS and and mean risk-adjusted LOS are calculated using the abstracted data. For each hospital, the model produces a median and 95% confidence interval for the standardized LOS ratio (SLOSR), which is the mean observed LOS divided by the mean predicted LOS.

2a.22 **Describe the method for discriminating performance** *(e.g., significance testing)***:**
Individual hospital performance is measured using the SLOSR and its 95% confidence interval.

2a.23 **Sampling (Survey) Methodology** *If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate)*:
the first 100 consecutive eligible patients per quarter

2a.24 **Data Source (***Check the source(s) for which the measure is specified and tested)*
Electronic clinical data, Electronic Health/Medical Record, Lab data, Paper medical record/flow-sheet

2a.25 **Data source/data collection instrument (***Identify the specific data source/data collection instrument, e.g. name of database, clinical registry, collection instrument, etc.***):**
ICU Outcomes Data Collection Instrument

2a.26-28 **Data source/data collection instrument reference web page URL or attachment:** Attachment ICU Outcomes Tool.pdf

2a.29-31 **Data dictionary/code table web page URL or attachment:** Attachment ICU Outcomes Data Dictionary.pdf

2a.32-35 **Level of Measurement/Analysis** (*Check the level(s) for which the measure is specified and tested)*

Clinicians: Other, Facility/Agency, Population: regional/network Hospital and ICU

2a.36-37 **Care Settings (***Check the setting(s) for which the measure is specified and tested)*
Hospital

2a.38-41 **Clinical Services** (*Healthcare services being measured, check all that apply*)
Clinicians: Physicians (MD/DO), Clinicians: Pharmacist, Clinicians: Chiropractor, Clinicians: Nurses

TESTING/ANALYSIS

2b. Reliability testing

2b.1 **Data/sample** *(description of data/sample and size)*: 11,295 ICU patients from 35 California hospitals between 2001-2004

2b.2 **Analytic Method** *(type of reliability & rationale, method for testing)*:
Data were reabstracted by auditors on a 5% random sample of patients. Kappa statistics were calculated for interrator variability between the data abstractor and the auditor. The auditors were clinical nurses who were trained by the authors and completed extensive sample chart abstraction.

2b.3 **Testing Results** *(reliability statistics, assessment of adequacy in the context of norms for the test conducted)*:
For physiologic variables of the MPM III LOS model, interrator reliability was excellent, with agreement ranging from 91.5 to 98.8%, and weighted kappa statistics ranging from 0.72-0.96.

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2c. Validity testing

2c.1 **Data/sample** *(description of data/sample and size)*: 40% of the sample (n =4,611) was used for validation of the model.

2c.2 **Analytic Method** *(type of validity & rationale, method for testing)*:
In order to assess model performance in the validation sample, multiple methods were used:
1. A paired Student's t-test was used to compare mean observed ICU LOS to mean predicted ICU LOS for the entire validation population and for specific subgroups.
2. After dividing into deciles of predicted LOS, a paired Student's t-test and calibration curves were used to compare mean observed LOS to mean predicted LOS.
3. Coefficients of determination were calculated to measure the variance in LOS. Bivariate regression of the mean observed LOS against the mean predicted LOS was performed to assess the proportion of variation across hospitals explained by the model.
4. The assessment of the MPM III LOS model was compared to the performance of the ICU of each hospital by calculation of a SLOSR.

2c.3 **Testing Results** *(statistical results, assessment of adequacy in the context of norms for the test conducted)*:
Difference between the mean observed LOS and predicted LOS in the validation sample was 0.2 hours for MPM III LOS (p = 0.90). MPM III LOS had a single age stratum with significant differences between observed and predicted LOS. However, it accurately predicted ICU LOS for medical and elective surgical patients. The MPM III LOS model's calibration curve demonstrated excellent fit across deciles of predicted ICU LOS. The grouped hospital-level coefficient of determination for ICU LOS predictions was 0.279, indicating that 28% of ICU LOS variations were accounted for by MPM III LOS. The SLOSRs of the MPM III LOS model ranged from 0.40 to 1.68.

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2d. Exclusions Justified

2d.1 **Summary of Evidence supporting exclusion(s):**
Records for patients who did not meet applicability criteria for the general MPM III mortality prediction model (i.e. cardiac surgery, acute myocardial infarction, burns, patients under the age of 18, and subsequent ICU readmission during a hospitalization) were excluded from analysis. These patient groups are excluded from general ICU mortality prediction models due to their need for unique risk-adjustment

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(e.g. TRISS in trauma patients, EuroSCORE in cardiac surgery patients, or PRISM in pediatric patients). Since the MPM III LOS model is based on the general mortality risk prediction MPM III model, the aforementioned patient groups were consistently excluded.

2d.2 Citations for Evidence:
Moore L, Lavoie A et al. The trauma risk adjustment model: a new model for evaluating trauma care. Ann Surg 2009 Jun;249(6):1040-6.
Nashef SA, Roques F et al. Validation of European System for Cardiac Operative Risk Evaluation (EuroSCORE) in North American cardiac surgery. Eur J Cardiothorac Surg 2002 Jul;22(1):101-5.
Pollack MM, Patel KM, Ruttimann UE. PRISM III: an updated Pediatric Risk of Mortality score. Crit Care Med 1996 May;24(5):743-52.

2d.3 Data/sample *(description of data/sample and size)*: Not-applicable

2d.4 Analytic Method *(type analysis & rationale)*:
Not-applicable

2d.5 Testing Results *(e.g., frequency, variability, sensitivity analyses)*:
Not-applicable

2e. Risk Adjustment for Outcomes/ Resource Use Measures

2e.1 Data/sample *(description of data/sample and size)*: 6,684 patients were used in the development sample in order to estimate coefficients for the MPM III LOS model.

2e.2 Analytic Method *(type of risk adjustment, analysis, & rationale)*:
Using all the variables in the original MPM III mortality model, mixed-effects, multilevel modeling was used to generate an ICU LOS prediction model based on the MPM III. The LOS was calculated in days to the second significant digit and truncated at 30 days to minimize the impact of outliers (as previous investigators have done).

2e.3 Testing Results *(risk model performance metrics)*:
Not-applicable

2e.4 If outcome or resource use measure is not risk adjusted, provide rationale: Not-applicable

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NA☐

2f. Identification of Meaningful Differences in Performance

2f.1 Data/sample from Testing or Current Use *(description of data/sample and size)*: The testing sample for the MPM III LOS model was 11,295 patients from 35 California hospital ICUs.

2f.2 Methods to identify statistically significant and practically/meaningfully differences in performance *(type of analysis & rationale)*:
In order to compare predictions of the models for hospital-level performance, a plot of LOS prediction model-specific SLOSRs for each hospital with at least 100 admissions was generated.

2f.3 Provide Measure Scores from Testing or Current Use *(description of scores, e.g., distribution by quartile, mean, median, SD, etc.; identification of statistically significant and meaningfully differences in performance)*:
There were similar ranges among the SLOSRs for each model as follows:
recalibrated APACHE IV LOS 0.47-1.60
MPM III LOS 0.40 - 1.68
SAPS II LOS 0.38-1.69
The intraclass correlations of the SLOSRs between each pair of models was high:
recalibrated APACHE IV LOS and MPM III LOS r = 0.89 (95% CI, 0.74-0.96)
recalibrated APACHE IV LOS and SAPS II LOS r = 0.85 (95% CI, 0.70-0.93)
MPM III LOS and SAPS II LOS r = 0.96 (95% CI, 0.92-0.98)

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2g. Comparability of Multiple Data Sources/Methods

2g
C☐

2g.1 Data/sample *(description of data/sample and size)*: Not-applicable **2g.2 Analytic Method** *(type of analysis & rationale)*: Not-applicable **2g.3 Testing Results** *(e.g., correlation statistics, comparison of rankings)*: Not-applicable	P☐ M☐ N☐ NA☒
2h. Disparities in Care **2h.1 If measure is stratified, provide stratified results** *(scores by stratified categories/cohorts)*: This measure is not stratified. **2h.2 If disparities have been reported/identified, but measure is not specified to detect disparities, provide follow-up plans:** Race/ethnicity could be added as a variable in the data collection tool (though it is not in the current tool). Results could easily be stratified if this variable was added.	**2h** C☐ P☐ M☐ N☐ NA☒
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Scientific Acceptability of Measure Properties?* 2a - P/C - only caveat is when to start ICU stay -- in the ED or PACU? What is the impact of the hospital infrastructure - could have a systematic bias is hospital structure limits moving patients in or out of ED or PACU - may affect comparability; this measure should be paired with the mortality measure; 2b solid reliability testing; 2c - validity testing of the model; reasonable exclusions; 2d. Risk Adjustment -- C=0.83 calibration curve; not yet publicly reported in CHART; Disparities -- not included in risk factors -- not stratified, though could be; Are there any racial differences in family/patient care goals or decisions?	**2**
Steering Committee: Overall, to what extent was the criterion, *Scientific Acceptability of Measure Properties*, met? **Rationale:** • The TAP rated this measure as high under scientific acceptability; it has a publicly available risk model that has been used and improved on for several years. • The SC discussed issues around identifying the time of onset, particularly patients coming from the emergency department and post-operative care and how patients are moved through different levels of care. • There were concerns that this measure would not capture readmission to the hospital. In the future this should be looked at, cannot be done in a short time frame. • SC Members were extremely interested in how disparities might be handled as cultural aspects could affect LOS. The developer noted that data for SES, race and ethnicity are generally not available. SC Members suggested insurance type might be one proxy. The SC encouraged the measure developers to think of ways to gather this information for future measures.	***2*** C☒ P☐ M☐ N☐
3. USABILITY	
Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making. (evaluation criteria)	Eval Rating
3a. Meaningful, Understandable, and Useful Information **3a.1 Current Use:** In use **3a.2 Use in a public reporting initiative (disclosure of performance results to the public at large)** (*If used in a public reporting initiative, provide name of initiative(s), locations, Web page URL(s). If not publicly reported, state the plans to achieve public reporting within 3 years*): UCSF supports the use of this measure by the California Hospital Assessment and Reporting Taskforce (CHART). Though it is not yet publicly reported, confidential reporting and quality improvement are ongoing. The intent is to have comparative hospital ICU LOS data available at www.calhospitalcompare.org. **3a.3 If used in other programs/initiatives (***If used in quality improvement or other programs/initiatives, name of initiative(s), locations, Web page URL(s). If not used for QI, state the plans to achieve use for QI within 3 years***):**	**3a** C☒ P☐ M☐ N☐

Although the MPM III mortality risk prediction model is used by Project IMPACT, the MPM III ICU LOS model is not known to be used by other programs or initiatives. **Testing of Interpretability** (*Testing that demonstrates the results are understood by the potential users for public reporting and quality improvement*) **3a.4 Data/sample** *(description of data/sample and size)*: This measure has not been specifically tested for interpretability by consumers, but once public reporting has begun, continued interpretability of the widely used website, www.calhospitalcompare.org, will be a surrogate test. Providers who use this measure for quality and efficiency improvement in California report no problems with interpretability. **3a.5 Methods** *(e.g., focus group, survey, QI project)*: Not-applicable **3a.6 Results** *(qualitative and/or quantitative results and conclusions)*: Not-applicable	
3b/3c. Relation to other NQF-endorsed measures **3b.1 NQF # and Title of similar or related measures:** NQF # 0334: PICU Severity-adjusted Length of Stay	
(for NQF staff use) **Notes on similar/related** endorsed **or submitted measures:**	
3b. Harmonization If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population): **3b.2 Are the measure specifications harmonized? If not, why?** Yes, though the targed population differs (pediatric vs. adult).	**3b** C☐ P☐ M☐ N☐ NA☒
3c. Distinctive or Additive Value **3c.1 Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:** Not-applicable **5.1 If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population), Describe why it is a more valid or efficient way to measure quality:**	**3c** C☐ P☐ M☐ N☐ NA☒
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Usability?* Currently in use in California; plan for reporting in CHART; should be paired with mortality measure	**3**
Steering Committee: Overall, to what extent was the criterion, *Usability*, met? **Rationale:** • Currently, this measure is being used in California by hospitals and plans to be included in public reporting. • In response to a question, the measure developer explained that teaching status doesn't have much of an impact- the higher predictive mortality rates the risk seems to be captured through this model. • Additional data from outside California would be helpful. • An SC member asked "Do clinicians who get the feedback believe that the measure distinguishes good care or overuse of care, or do providers who are expected to have good care appear to look good with this measure?" • The goal is to match the clinical outcome with a utilization outcomes and the LOS measure and mortality measures should be endorsed together as they both support each other • Some SC Members indicated a strong preference for stratification by race/ethnicity or SES	**3** C☒ P☐ M☐ N☐
4. FEASIBILITY	
Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement. (evaluation criteria)	Eval Rating
4a. Data Generated as a Byproduct of Care Processes	**4a**

4a.1-2 **How are the data elements that are needed to compute measure scores generated?** Data generated as byproduct of care processes during care delivery (Data are generated and used by healthcare personnel during the provision of care, e.g., blood pressure, lab value, medical condition), Coding/abstraction performed by someone other than person obtaining original information (E.g., DRG, ICD-9 codes on claims, chart abstraction for quality measure or registry)	C☐ P☐ M☒ N☐
4b. Electronic Sources 4b.1 **Are all the data elements available electronically?** (*elements that are needed to compute measure scores are in defined, computer-readable fields, e.g., electronic health record, electronic claims*) No 4b.2 **If not, specify the near-term path to achieve electronic capture by most providers.** There already exist electronic medical record options that hospitals could purchase that would collect this data. However, most hospitals have not yet purchased such software.	**4b** C☒ P☐ M☐ N☐
4c. Exclusions 4c.1 **Do the specified exclusions require additional data sources beyond what is required for the numerator and denominator specifications?** No 4c.2 **If yes, provide justification.**	**4c** C☒ P☐ M☐ N☐ NA☐
4d. Susceptibility to Inaccuracies, Errors, or Unintended Consequences 4d.1 **Identify susceptibility to inaccuracies, errors, or unintended consequences of the measure and describe how these potential problems could be audited. If audited, provide results.** The potential unintended consequence is that hospitals may seek to avoid high-risk patients (who, due to the severity of their illness, require longer ICU lengths-of-stay). One could monitor this behavior by evaluating changes in hospitals' risk-profiles over time.	**4d** C☒ P☐ M☐ N☐
4e. Data Collection Strategy/Implementation 4e.1 **Describe what you have learned/modified as a result of testing and/or operational use of the measure regarding data collection, availability of data/missing data, timing/frequency of data collection, patient confidentiality, time/cost of data collection, other feasibility/ implementation issues:** In 188 hospitals in California (from small rural hospitals to the largest teaching hospitals), we have successfully collected this data. The average time per chart for an experienced data collector is 11-15 minutes. We collect data on 100 patients per quarter to minimize the data collection burden while still getting sufficient sample size to get precise estimates of hospital performance. However, an alternative target sample size could easily be chosen by users. 4e.2 **Costs to implement the measure** (*costs of data collection, fees associated with proprietary measures*)**:** The measures are not proprietary, and we can provide the data collection form and data dictionary for free. The cost of 11 minutes of data collection per patient will vary by region, but in general we recommend that a nurse collect the data. 4e.3 **Evidence for costs:** Kuzniewicz MW, Vasilevskis EE, Lane R et al. Variation in ICU risk-adjusted mortality: impact of methods of assessment and potential confounders. Chest 2008 Jun;133(6):1319-27. 4e.4 **Business case documentation:** Not-applicable	**4e** C☒ P☐ M☐ N☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Feasibility?* 4a - very compatible with EHRs - some vendors have built in; usually abstraction is used (reflects slow pace of EHR adoption); CHART has an electronic submission software also; 4d - trauma, burns, CBAG are	**4**

excluded due to unique characteristics of these patients. First 100 patients per quarter data collection for ease.	
Steering Committee: Overall, to what extent was the criterion, *Feasibility*, met? **Rationale:** • This measure is very compatible with EHRs. • AN SC member noted that the measure requires significant data abstraction even with electronic records and is therefore labor intensive which decreases usability and feasibility when it is to be reported on 400 patients each year.	**4** **C**☒ **P**☐ **M**☐ **N**☐
RECOMMENDATION	
(for NQF staff use) **Check if measure is untested and only eligible for time-limited endorsement.**	**Time-limited** ☐
Steering Committee: Do you recommend for endorsement? **Comments:**	**Y**☒ **N**☐ **A**☐

CONTACT INFORMATION

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Co.1 Organization
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Measure Developer If different from Measure Steward
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Co.6 Additional organizations that sponsored/participated in measure development

ADDITIONAL INFORMATION

Workgroup/Expert Panel involved in measure development
Ad.1 Provide a list of sponsoring organizations and workgroup/panel members' names and organizations. Describe the members' role in measure development.
not-applicable

Ad.2 If adapted, provide name of original measure: not-applicable
Ad.3-5 If adapted, provide original specifications URL or attachment

Measure Developer/Steward Updates and Ongoing Maintenance
Ad.6 Year the measure was first released: 2008
Ad.7 Month and Year of most recent revision: 07, 2009
Ad.8 What is your frequency for review/update of this measure? annually
Ad.9 When is the next scheduled review/update for this measure? 07, 2010

Ad.10 Copyright statement/disclaimers: is in the public domain

Ad.11 -13 Additional Information web page URL or attachment:

Date of Submission (*MM/DD/YY*)**:** 06/29/2010

ICU-Outcomes Data Collection Instrument

Data Dictionary

Table of Definitions

PATIENT ELIGIBILITY

Note: Patients must have 1:1 or 1:2 nurse to patient ratio at admission to be considered an ICU admission. If >1:2 ratio on admission do not abstract for this patient.

A. Is the patient ≥ 18 years of age at the time of admission to the ICU?

Justification MPM II validated on adult populations.

Instructions

- Select "Yes" if on the date of ICU admission, the patient is equal to or older than 18 years of age.
- The most consistent place to find the ICU admission time and date are on the ICU flowsheet. The first thing that a nurse does when a patient arrives in the ICU is to take vital signs, and this information is recorded on the flowsheet with the date and time.

  If this information cannot be found on the flowsheet, look in the nurses' notes or physician's progress notes. And finally, you can refer to the admission orders for this information, but this is the least likely place to find the admission time documented.

  When discrepancies occur in time of admission, refer to:

- **1st: Vital Signs taken on admission to ICU**
- **2nd: Nurses' Notes or Progress Notes**
- **3rd: Admission Orders**

Preferred Sources: ICU Vital Sign Flow sheet, Progress Notes, Nursing Admission Note, Graphic Sheet, Admission orders.

B. Is this the patient's first ICU admission during the current hospitalization?

Justification Excluded from MPM model. Characteristics of patients who are readmitted are different than those patients on index presentation.

Instructions

- Select "Yes" if the patient has never been admitted to the ICU during this current hospitalization.
- Select "Yes" if patient has been admitted to the intensive care unit in a prior hospitalization, but this is the first episode during this hospitalization.

- Select "Yes" if patient is being transferred from another acute care hospital and was in the ICU at any point during the outside hospital admission.

Preferred Sources: Physician progress notes, Nursing progress notes, Physicians order sets, transfer summaries, Respiratory therapists' notes.

C. Was the patient cared for in the ICU ≥ 4 hours?

Justification Defines patients who have had care provided in the ICU

Instructions

- Select "Yes" if the patient has been cared for in your ICU for ≥ 4 hours.
- If transferred from an outside hospital's ICU, do not include the amount of time at the outside hospital's ICU.
- This applies only to the index or first ICU admission during the current hospitalization.
- The most consistent place to find the ICU admission time and date are on the ICU flowsheet. The first thing that a nurse does when a patient arrives in the ICU is to take vital signs, and this information is recorded on the flowsheet with the date and time.

  If this information cannot be found on the flowsheet, look in the nurses' notes or physician's progress notes. And finally, you can refer to the admission orders for this information, but this is the least likely place to find the admission time documented.

When discrepancies occur in time of admission, refer to:

- **1st: Vital Signs taken on admission to ICU**
- **2nd: Nurses' Notes or Progress Notes**
- **3rd: Admission Orders**

Preferred Sources: ICU Vital Sign Flow sheet, Progress Notes, Nursing Admission Note, Graphic Sheet, Admission orders.

D. Was the patient's primary reason for admission due to Trauma, Burns, or immediately after Coronary Bypass Graft Surgery?

Justification MPM II exclusion criteria

Instructions Select "Yes" if there is *explicit* documentation indicating that the principal operative procedure performed on this patient that resulted in the index ICU admission was secondary to *burns, trauma or surgery for trauma, or coronary bypass graft surgery.* For the purposes of this question, only select "Yes" if at least one of the following criteria is met:

- There is explicit documentation by a physician of the terms "burns", "trauma", "traumatic", and/or "…secondary to trauma" used in the

context of the injury that resulted in this patient's index ICU admission and/or principal operative procedure, and/or

- There is explicit documentation in the patient's record that the *principal operative procedure* performed on this patient that resulted in the index ICU admission was a coronary artery bypass graft (CABG).
- There is explicit documentation that the principal operative procedure occurred in the immediate context of any of the following:
  - Bites
  - Blast Injuries Secondary to Explosions
  - Blunt Trauma
  - Burns (Thermal, Chemical, or Electrical)
  - Crush Injuries
  - Drowning
  - Electrical Injuries
  - Falls
  - Fights
  - Gun Shot Wounds / Firearm Injuries
  - Motor Vehicle Accident
  - Multiple Trauma
  - Physical Altercations
  - Stab Injuries
  - Stings
  - Suicide Attempts
  - Toxic/Chemical Injuries

Check "No" to this question if any of the following criteria are met:

- The procedure is elective and/or occurring in the context of a scheduled admission.
- There is no documentation indicating that the principal operative procedure was secondary to trauma or a traumatic event, and/or any of the following descriptors are used to describe the injury: "atraumatic", "non-traumatic", and/or "not secondary to trauma".
- Any surgery other than CABG performed on the vessels of the heart; Operations on structures adjacent to the heart valves, such as papillary muscles or chordae tendinae; Repair of septal defects; Replacement or repair of aortic mitral (bicuspid), tricuspid, or pulmonary valve; V-valvotomy; valvuloplasty.
- A patient who is in a Burn or Trauma unit, though has a non burn or trauma related diagnosis should not be excluded.

Preferred Sources: Emergency Department Record, Physician Admission Note, Anesthesia Assessment, Operative Report, Discharge Summary/ICD-9 Diagnosis

E. Was the patient admitted to "rule out MI", and subsequently determined not to have a myocardial infarction, or another acute process requiring ICU care?

Justification MPM II exclusion criteria

Instructions Select "Yes" if there is *explicit* documentation indicating that the principal reason for the current admission to the ICU for this patient was to "rule out a myocardial infarction", and subsequent anaylsis confirmed the absence of evidence consistent with myocardial infarction AND there was no additional reason to treat the patient within the ICU. For the purposes of this question, only select "Yes" if at least one of the following criteria is met:

- There is explicit documentation by a physician of the terms "rule out MI", "rule out myocardial infarction", "rule out acute coronary syndrome", and/or "rule out ACS" used in the a patient admitted with symptoms suggestive of a diagnosis of myocardial infarction (e.g. chest pain, shortness of breath).
- There is explicit documentation in the patient's record that the *principal procedure* performed on this patient that resulted in the current ICU admission was limited to coronary angiogram without stenting / angioplasty / atherectomy and/or EKGs and/or laboratory analysis (e.g. troponin, myoglobin, creatine kinase levels) used to evaluated for the presence of a myocardial infarction.
  - There is explicit documentation that a troponin was within normal limits (Note: The lower limit of normal will vary from hospital to hospital) or per physician note was not felt to be consistent with a myocardial infarction.

Check "No" to this question if any of the following criteria are met:

- There is a physician's, physician assistant's, and/or nurse practioner's note stating that the patient has experienced an ACUTE myocardial infarction, or acute MI, or acute coronary syndrome, or ACS, acute ST elevation MI, acute Q-wave MI, acute non-ST elevation MI.
- There is evidence that a patient was admitted to "rule out MI" and went to the cardiac catheterization lab and underwent any of the following:
  - Balloon Angioplasty
  - Stent placement (Bare metal or Drug Eluting)
  - Balloon Angioplasty with Stent Placement
  - Balloon Angioplasty and/or Laser Angioplasty
  - Directional Coronary Atherectomy (DCA)
  - Intravascular Coronary Atherectomy (ICA)
  - Rotablator
  - Transluminal Extraction Catheterization (TEC)
- There is evidence that the patient went for an urgent / emergent coronary artery bypass graft surgery

Preferred Sources: Emergency Department Record, Physician Admission Note, Cardiology Notes, Discharge Summary/ICD-9 Diagnosis

SECTION I. CASE/PATIENT INFORMATION

I-1 Abstractor's Certification number

Definition A unique identifier assigned to data collectors after completing ICU process measures data collection training materials.

Justification Allows identification using non personalized information of data collectors and ensures the completion of training materials prior to data collection.

Instructions

- Enter the abstractor's certification number exactly.
- Include any appropriate zeros and alpha characters.
- Omit hyphens or other punctuation.
- Each abstractor certification number is unique for each data collector who participates in data collection activities.
- Enter a separate certification number for each individual who is involved with the data collection process (For example if one individual collects patient characteristic on admission and a different individual collects past medical history information they would each enter in their number in the space provided in I-1.

Preferred Source: This number is an assigned number by the administration.

I-2 Hospital ID Number (#)

Definition Unique identifier assigned to each hospital.

Justification Allows identification of unique hospitals from one another.

Instructions Enter the unique hospital identifier assigned to your hospital.

Preferred Source: This number is an assigned number by the administration

I-1 Hospital Medical Record Number

Definition The unique number assigned to each patient within a hospital that distinguishes the patient and hospital record from all others in that institution.

Synonyms Med Rec, Med Rec #, MR, MRN, MR#, Record Number, Patient #

Exclusions Acct #, Billing #, Control #, Encounter #, Episode #, History #, Hospital #Medical history #, Medical record/acct #, MHN, Registration #, Unit #, URN

Justification Allows identification of one patient from another.

Instructions

- Enter the patient's medical record number exactly
- Include any appropriate zeros and alpha characters.
- Omit hyphens or other punctuation

Preferred Source: Face Sheet
Other Sources: Admission Record, ER Record, Registration Form, Admission H&P

I-4 Hospital Account Number (aka case number)

Definition Unique identifier assigned consecutively by hospital to a case upon admission to the hospital.

Synonyms Abstract #, Acct #, Account #, Billing #, Billing ID, Control #, Encounter #, Episode #, Patient Control #

Exclusions Med Rec, Med Rec #, MR, MRN, MR#, Record Number

Justification Allows identification of one set of admission data from another.

Instructions Enter the unique identifier assigned to this inpatient admission to your hospital.

Preferred Source: Face Sheet
Other Sources: Admission Record, ER Record, Registration Form, Admission H&P

I-5 Social Security Number (SSN)

Definition Nine Digit Identification Number issued to citizens, permanent residents, and temporary (working) residents by the Social Security Administration of the government of the United States.

Justification Allows identification of one patient from another

Instructions

- Enter the patient's Social Security Number exactly as it appears on the face sheet.
- If no Social Security Number is available, enter a hyphen in the first space where you would have entered the Social Security Number.

Preferred Source: Face Sheet

Other Sources: Admission Record, ER Record, Registration Form, Admission H&P

I-6 Patient's date of birth (DOB) or age if only age is known

Definition The patient's date of birth or age if only age is known.

Justification MPM II.

Instructions

- Enter patient's birth date using mm/dd/yyyy format.
- When the complete date of birth is unknown, as much of the date as is known should be reported. At a minimum, an approximate year of birth should be reported. If the month and year of birth are known, and the exact day is not, the year, the month and zeros for the day shall be reported. If only the age is known, the age should be reported.
- If there is no documentation or conflicting documentation on the face sheet, look at additional sources. If there is no documentation or conflicting documentation on the additional sources, enter all zeros.

Preferred Source: Face Sheet
Other Sources: Admission Record, ER record, Registration Form

I-7 Sex

Definition The sex of the patient at the start of care.

Justification Sex is important for reporting demographic statistics for admissions to your unit.

Instructions

- Select one of the following to indicate the sex of the patient
  - M for Male
  - F for Female

Preferred Source: Face Sheet
Other Sources: Admission Record, ER record, Registration Form, Nursing Admission Assessment, Admission H&P

SECTION II. HOSPITAL ARRIVAL / INDEX ICU ADMISSION

II-1 Date of Arrival to your Hospital

Definition The date the patient arrived at your hospital that encompasses the index ICU stay.

Justification: The date of arrival to your hospital is used to calculate length of stay in the hospital and account for lead time bias.

Instructions

- Enter the date the patient arrived at the hospital for a continuous hospital stay that included the index ICU admission in your hospital.
- Use mm/dd/yyyy format
- Review only acceptable sources to determine the earliest date the patient arrived at the hospital. *Do Not* use the face sheet, addressographs or stamps or ambulance records for this information. The intent of this variable is to capture the earliest date the patient was physically in the hospital. This may differ from the admission date.
- If the patient entered through the emergency department, arrival dates can be taken from triage nurse assessments, signed consent forms, and half and half ER form (half registration/half clinical information or consent form). If any of the documented dates conflict in regards to date of hospital arrival, record the earliest of the documented dates.
- If the patient is admitted for 23-hour observation and later admitted to the unit or floor, abstract the date the patient arrived at the hospital for the 23-hour observation.
- If the patient is admitted to the hospital to a non-acute care unit (i.e. psychiatric facility, skilled nursing facility, long term care facility, or rehabilitation facility) and is then transferred to acute care, the arrival date would be the date the patient is transferred to the acute care unit.
- If the patient is in an outpatient setting of the hospital (e.g., undergoing dialysis, chemotherapy or an outpatient procedure) and is subsequently admitted to the hospital, use the date the patient presents to the ED or arrives on the floor as the arrival date.

Preferred Sources: Triage Nursing Notes, Emergency Room Notes, Signed Consent Forms, Nursing Admission Assessment, Vital Signs Graphic Record, Admission H&P

II-1 Time of Arrival to your Hospital

Definition The time the patient arrived at your hospital for a continuous hospital stay that encompasses the index ICU admission. (Note: Arrival time to the hospital and ICU admission time are not necessarily the same)

Justification The time of arrival in a hospital is used to calculate length of stay in the hospital and lead time bias.

Instructions

- Enter the hour and minutes the patient arrived at your hospital using the 24 hour clock format hh:mm (military format – see below).
- Review only acceptable sources to determine the earliest time the patient arrived at the hospital. *Do Not* use the face sheet, addressographs or stamps or ambulance records for this information. The intent of this variable is to capture the earliest time the patient was physically in the hospital. This may differ from the admission time.

- If the patient entered through the emergency department, arrival times can be taken from triage nurse assessments, signed consent forms and half and half ER form (half registration/half clinical information or consent form). If any of the documented times conflict in regards to exact time of hospital arrival, record the earliest of the documented times.
- If the patient is admitted for 23-hour observation and later admitted to the unit or floor, abstract the time the patient arrived at the hospital for the 23-hour observation.
- If the patient is admitted to the hospital to a non-acute care unit (i.e. psychiatric facility, skilled nursing facility, long term care facility, or rehabilitation facility) and is then transferred to acute care, the arrival time would be the time the patient is transferred to the acute care unit.
- If the patient is in an outpatient setting of the hospital (e.g., undergoing dialysis, chemotherapy or an outpatient procedure) and is subsequently admitted to the hospital, use the time the patient presents to the ED or arrives on the floor as the arrival time.

Military Time

HH = Hour (00-23)
MM = Minutes (00-59)

Military Time – A 24-hour period from midnight to midnight using a 4-digit number of which the first two digits indicate the hour and the last two digits indicate the minute.

Converting clock time to military time:
With the exception of Midnight and Noon:

* If the time is in the a.m., conversion is not required.
* If the time is in the p.m., add 12 to the clock time hour.

For example:

Midnight – 00:00	Noon – 12:00
5:31 am – 05:31	5:31 pm – 17:31
11:59 am – 11:59	11:59 pm – 23:59

Preferred Sources: Emergency Room notes, History and Physical, Progress Notes, Nursing Admission Assessment, Triage Record

II-2 Date of Admission to your ICU Unit (Index ICU Admission)

Definition The earliest documented date of the patient being physically in a bed in your ICU.

Justification Date/time of admission to your unit and date/time of discharge from your unit are used to calculate length of stay in your unit. Date of admission to your hospital and date of admission to your unit are used to calculate days at source prior to admission to your unit.

Instructions

- Enter the date the patient was admitted to your unit
- Use the mm/dd/yyyy format.
- A four-digit year must be entered.
- For Pre-operative monitoring patients: If patient is admitted to the ICU for pre-operative monitoring ONLY, and goes to surgery ≤ 48 hours from the time of ICU admission, ICU admission date should be the date the patient returned from the operating room / recovery room. If the patient goes to surgery > 48 hours from the time of ICU admission, ICU admission date should be the initial date that the patient was admitted to the ICU prior to the surgery.
- The most consistent place to find the ICU admission time and date are on the ICU flowsheet. The first thing that a nurse does when a patient arrives in the ICU is to take vital signs, and this information is recorded on the flowsheet with the date and time.

  If this information cannot be found on the flowsheet, look in the nurses' notes or physician's progress notes. And finally, you can refer to the admission orders for this information, but this is the least likely place to find the admission time documented.

  When discrepancies occur in time of admission, refer to:

- **1st: Vital Signs taken on admission to ICU**
- **2nd: Nurses' Notes or Progress Notes**
- **3rd: Admission Orders**

Preferred Sources: ICU Vital Sign Flow sheet, Progress Notes, Nursing Admission Note, Graphic Sheet, Admission orders.

II-2 Time of Admission to your ICU Unit

Definition The earliest documented time of the patient being physically in a bed in your ICU unit.

Justification The date/time of admission to your unit and the date/time of discharge from your unit are used to calculate length of stay in your unit. Time of admission to your unit is important data to describe activity and utilization.

Instructions

- Enter the hour and minutes the patient was admitted to your unit in hh:mm using the 24 hour clock (military format – see below).
- For Pre-operative monitoring patients: If patient is admitted to the ICU for pre-operative monitoring ONLY, and goes to surgery ≤ 48 hours from the time of ICU admission, ICU admission time should be the time the patient returned from the operating room / recovery room. If the patient goes to surgery > 48 hours from the time of ICU admission, ICU

admission time should be the initial time that the patient was admitted to the ICU prior to the surgery.

- The most consistent place to find the ICU admission time and date are on the ICU flowsheet. The first thing that a nurse does when a patient arrives in the ICU is to take vital signs, and this information is recorded on the flowsheet with the date and time.

  If this information cannot be found on the flowsheet, look in the nurses' notes or physician's progress notes. And finally, you can refer to the admission orders for this information, but this is the least likely place to find the admission time documented. When discrepancies occur in time of admission, refer to:

- **1st: Vital Signs taken on admission to ICU**
- **2nd: Nurses' Notes or Progress Notes**
- **3rd: Admission Orders**

Allowable Values

HH = Hour (00-23)
MM = Minutes (00-59)

Military Time – A 24-hour period from midnight to midnight using a 4-digit number of which the first two digits indicate the hour and the last two digits indicate the minute.

Converting clock time to military time:
With the exception of Midnight and Noon:

* If the time is in the a.m., conversion is not required.
* If the time is in the p.m., add 12 to the clock time hour.

For example:

Midnight – 00:00	Noon – 12:00
5:31 am – 05:31	5:31 pm – 17:31
11:59 am – 11:59	11:59 pm – 23:59

Preferred Sources: ICU Vital Sign Flow sheet, Progress Notes, Nursing Admission Note, Graphic Sheet

II-3 Type of ICU to Which Patient Admitted

Definition

The classification of intensive care unit at the time of admission. ICU types are defined by groups of physicians, nursing staff, and procedures used in the care for patients with similar medical or surgical illnesses. The possible unit types include:

- Coronary Care Unit or CCU: A unit for non-surgical cardiac emergencies, where there is continuous EKG and physiologic monitoring. Common cardiac emergencies include acute coronary syndrome, myocardial infarction, congestive heart failure, and cardiac arrhythmias.

- Cardiothoracic: Unit specializing in care for peri-operative care of patients undergoing cardiac or thoracic surgical procedures. Most common procedures include coronary artery bypass grafting, valve replacements, aneurysm repairs, septal defects, heart transplant, etc…
- Medical: Unit specializing in the care non-cardiac, non-surgical critical illness. Common diagnoses include pneumonia, sepsis, DKA, GI bleed, ARDS, overdose, etc…
- Combined Medical /Surgical: Unit in which clinical providers care for both medical and surgical patients with critical illness. See definition for Medical and Surgical ICU.
- Neurosurgical: Unit specializing in the care for patients with head or spinal trauma and/or peri-operative care of patients undergoing neurosurgical procedures. Units specialize in use of intracranial pressure monitoring devices, lumbar drains, and ventricular shunts. Common procedures include craniotomies for tumors and bleeding, aneurysm repairs, and placement of monitoring devices.
- Respiratory: Unit specializing in the monitoring and treatment of patients with acute respiratory failure due to a primary respiratory cause and of patients with chronic respiratory failure. Organ failure is usually limited to that of the respiratory system.
- Surgical: Unit specializing in the care for peri-operative care of patients undergoing general surgical procedures and for patients experiencing hemodynamic instability following a planned or emergency surgical intervention.
- Trauma. Unit specializing in the care for patients who have severe internal, orthopedic, and/or neurologic injuries resulting from trauma.

Justification

Identifies each participating unit so that hospitals are able to utilize the data they will collect and receive back according to unit type / location. Unit location is important data to describe activity and utilization.

Instructions

- Select the type of intensive care unit to which the patient is admitted to for the index ICU admission as described above.
- An ICU *excludes* bone marrow transplant units and nursing areas that provide step-down, intermediate care or telemetry only.
- The type of ICU is determined by the service designation of the majority of patients cared for by the unit (i.e., if 80% of the patients are on a certain service [e.g., general surgery], then the ICU is designated as that type of unit [e.g., surgical ICU].
- An ICU with approximately equal numbers of medical and surgical patients is designated as a combined medical/surgical ICU.
- If unable to identify the type of unit, please indicate Other/Unknown.
- For patients whose primary diagnosis is a cardiac disorder do not assume care unit is a CCU. Mark CCU only >80% of patients cared for are cardiac.

Preferred Sources: ICU Admission H&P, Physician Progress Notes, Nursing Notes

SECTION III. SITE IMMEDIATELY PRIOR TO THIS ICU ADMISSION

General Instructions for Section III

The intent of these items is to document where the patients were before they came to your ICU. If the patient was in your hospital immediately before coming to ICU, then indicate in III-1a (described in more detail below) from which unit, and the date / time they entered the previous *unit*.

If the patient was in another hospital immediately before coming to the ICU then indicate the date they were admitted to the previous hospital.

III–1 Site Immediately Prior to ICU Admission to Your Unit (Index ICU Admission)

Definition The physical site and/or the area where the patient was located directly prior to this admission to your unit. Possible unit locations include:

- Your Hospital: If admitted from any acute care unit including medical/surgical floor, other ICU, operating room, recovery room, procedural area (e.g. cardiac catheterization lab) in your hospital. This does not include skilled nursing facilities (SNF), rehabilitation units, or hospice units that may be located within the hospital.
- Another Acute Care Hospital: If admitted from any acute care unit at an outside hospital including medical/surgical floor, ICU, operating room, recovery room, or procedural area (e.g. cardiac catheterization lab) in the outside hospital. This does not include the emergency department, SNF, rehabilitation unit, or hospice unit that may be located within the outside hospital.
- Skilled Nursing / Intermediate Care: Either an independent facility, or a distinct part of a hospital that provides 24-hour skilled nursing care that does not require the level of care provided in a hospital; includes services such as physical, speech and occupational therapy; assistance with personal care activities such as eating, walking, toileting and bathing; coordinated management of patient care; social services; and other activities.
- Rehabilitation: Either an independent facility, or a distinct part of a hospital, that provides nursing and/or physical or cognitive therapies to any acutely hospitalized individual who has a new disability (or and exacerbation of an existing one). This can vary from weakness-related inability to walk or perform activities of daily living (ADLs), to new swallowing difficulties, to higher-level thinking or behavior deficits. Common diagnoses requiring rehabilitation include: Stoke, spinal cord injury, amputation, trauma, fractures, brain injury, polyarthritis,

neurologic disorders including multiple sclerosis, Parkinson's disease, polyneuropathy, motor neuron diseases.

- Direct Admit – Physician: Admission under the direction of a physician caring for the patient. Common direct admissions would include the admission of a patient directly from an outpatient clinic visit, a direct admission for chemotherapy, or an admission to secure an ICU be pre-operatively.
- Home: A patient admitted from the patient's home, the home of a relative or friend, or a vacation site, whether or not the patient had been receiving home health services or hospice care at home.
- Other: A patient admitted from a source other than mentioned, including patients admitted from a hospice facility, nursing home, or extended care facility

Justification Administrative information for tracking ICU admission sources and mortality.

Instructions

- Select one of the following to indicate the physical site where the patient was located directly prior to this admission to your unit:
  - Your Hospital
  - Another Acute-Care Hospital
  - Skilled Nursing Facility / Intermediate Care.
  - Rehabilitation Unit
  - Direct Admit - Physician
  - Home
  - Other
- If a patient is located in a SNF, intermediate care facility, rehab facility, etc… and first goes to the emergency department, the department / site prior to admission should be documented as the emergency department.

Preferred Sources: ER Report, Admission H&P, Physician Progress Notes, Transfer Notes, Nursing Notes

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III-1a If from a location within your hospital prior to ICU admission (choice "a" in III-1), what department/unit? Date and time entered the unit.

Definition The hospital unit prior to ICU admission is the location in which patient received care immediately prior to ICU admission. Possible hospital units include:

- Ward or Floor Unit: Division of a hospital (or a suite of rooms) shared by patients who need a similar kind of care (medical, surgical, neurologic, and psychiatric, etc…). There is daily physician staffing and 24 hour nursing care, though level of care typically does not requiring 24 hour physiologic monitoring.

- Emergency Department: Department in a hospital licensed to provide emergency medical services prior to the admission of patient to the hospital.
- Cardiac Catheterization Lab: A procedural area used primarily for insertion of a catheter into a blood vessel with the purpose of guiding it to the heart to evaluate the coronary arteries, aorta, cardiac valves, and/or hemodynamics. Common procedures include, but are not limited to:
  - Percutaneous transluminal coronary angioplasty (PTCA)
  - Coronary artery stenting
  - Balloon angioplasty
  - Coronary angiography
  - Coronary atherectomy
  - Intra-coronary ultrasound
  - Cardiac septal ablation
  - Balloon valvuloplasty
- Room or Surgical Recovery Room: An operating room is a room in a hospital used for the performance of surgical operations. The operating room may be inside a hospital, a same day/ambulatory surgery facility, or even a doctor's office. An operating room does not include medical procedure rooms (e.g. endoscopy, bronchoscopy, interventional radiology, cardiac catheterization laboratory, dialysis.

  A surgical recovery room is an area of a hospital used for the close monitoring of people who have had an operation in which anesthesia was given.
- Step Down / Transitional Care Unit: A unit in the hospital where patients receive a lower, or less intense, level of care than they would get in the ICU. However, they receive a higher level of care than they would get if sent to a regular inpatient unit. Machines in a telemetry unit measure specific body functions. The most common measurements are heart rate and electrocardiogram, or ECG. Blood pressure, rate of breathing, temperature, and level of oxygen in the blood can also be measured if needed. Various machines are available to make these measurements. After the machines record and send the data, trained staff in the central monitoring area can watch for any problems.
- Other ICU: i.e. Coronary Care / CCU, Cardiothoracic, Medical, Combined Medical / Surgical, Neurosurgical, Respiratory, Surgical, Trauma
- Unknown: From the documentation provided it cannot be determined the location from which the patient was admitted to the ICU. Only use this selection if there is no documentation that provides direction as to where the patient was transferred from.

Justification The prior location is used to address lead time bias.

Instructions

- If the patient was in your own hospital prior to ICU admission, select the type of unit/area within the hospital where the patient was located.
- Enter the date (mm/dd/yyyy), and time (military format) that the patient entered that unit immediately prior to index ICU admission.
- If the patient was on a medical/surgical floor and leaves the unit for a test or non-surgical procedure (e.g. endoscopy, bronchoscopy, colonoscopy, interventional radiology) and is admitted directly from the testing/procedural area, enter the unit/area from which the patient was sent to undergo the test/procedure.
- If the patient was on a medical/surgical floor and leaves the unit for a surgical procedure and an incision was NOT made or anesthesia was NOT delivered, the source of admission should be the medical or surgical floor from which they came.
  - Only select surgical recovery room or operating room if an incision was made and/or anesthesia delivered in an operating room.
- If location is operating room or surgical recovery room, see next definition for clarification if emergency or elective surgery was performed.

Preferred Sources: Admission H&P, Physician Progress Notes, Transfer Notes, Nursing Notes

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III-1b If your choice above is "b" (Another Hospital) ⇨ Enter date the patient was admitted to the prior *hospital*.

Definition The date the patient was admitted to the outside hospital prior to transfer to the current hospital ICU admission.

Justification The prior location is used to address lead time bias.

Instructions

- If the patient was admitted from an outside hospital prior to ICU admission enter the date and time the patient entered the outside *hospital* immediately prior to index ICU admission.
- Prior hospital must be an acute care hospital. (Does not include SNF, psychiatric units, long term care units, rehabilitation units that are separate units within a hospital).

Preferred Sources: Transfer Notes, History and Physical (H&P), Physician Progress Notes, Nursing notes

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SECTION IV. PATIENT CHARACTERISTICS ON ICU ADMISSION

IV-1 Was the patient receiving mechanical ventilation at ICU admission or within one hour after arrival to the ICU?

Definition

- Mechanical Ventilation is defined as all or some of the breaths, or a portion of the breaths (pressure support), are delivered by a mechanical device. It is a treatment where some or all of the energy required to increase lung volume during inspiration is supplied by a mechanical device. Hand ventilation by a member of the clinical team is considered mechanical ventilation.
- High frequency and jet ventilators, negative pressure ventilators, and BIPAP are considered as mechanical ventilation.
- CPAP is not considered mechanical ventilation.

Justification MPM II

Instructions

- Select "Yes" or "No" to indicate if mechanical ventilation was commenced at admission to your unit or in the first hour after admission to your unit. (e.g. if the patient was admitted and not intubated at 13:01, but mechanical ventilation begins at 13:55, one would mark Yes).

Preferred Sources: Respiratory Therapist Record Sheet, ICU flowsheet, nurses' notes, progress notes.

IV-2 Cardiopulmonary resuscitation (CPR) within 24 hrs prior to Admission?

Definition

- Cardiopulmonary resuscitation (CPR) includes chest compressions, electrical defibrillation, or cardiac massage.
- CPR is performed in Advanced Cardiac Life Support algorithms for pulseless electrical activity arrest (PEA), ventricular fibrillation, unstable ventricular tachycardia.
- Precordial thumps without cardiac massage, or chest compressions are not considered CPR.
- Emergent intubation without chest compressions, defibrillation, or cardiac massage is not considered CPR.

Justification MPM II

Instructions

- Select "Yes" or "No" to indicate whether the patient received cardiopulmonary resuscitation within 24 hours **prior** to the admission to your unit, irrespective of where cardiopulmonary resuscitation was administered.
- CPR information may be found in a "code blue" note in the 24 hours prior to admission.
- CPR is a standard part of the Advanced Cardiac Life Support (ACLS) protocol. Select "Yes" if indicated that patient received ACLS measures in the 24 hours prior to admission.

- Do not include cardiopulmonary resuscitation received after admission to your unit.

Preferred Sources: ER Reports, Transfer notes, Admission H&P, EMT record, "Code Blue Note".

IV-3 Did the patient have intracranial mass effect at ICU admission or diagnosed within one hour after arrival to the ICU?

Definition Includes an intracranial abscess, tumor, hemorrhage, and/or subdural hematoma identified by CT or other imaging modality with documentation of any of the following by physician.

- Midline shift
- Obliteration or distortion of cerebral ventricles
- Gross hemorrhage in cerebral ventricles or subarachnoid space
- Visible mass > 4 cm
- Any mass that enhances with contrast media

Justification MPM II

Instructions

- Select "Yes" or "No" to indicate if the patient had an intracranial mass (i.e., abscess, contusion, hemorrhage, edema, tumor) identified by CT or other imaging modality that meets the above criteria.
- Select "Yes" if the mass effect is known within 1 hour after ICU admission.
- Imaging must be present in order to document intracranial mass effect. Physicians and nurses notes without imaging are not sufficient to qualify regardless of patient's medical history.

Preferred Sources: Radiology Reports, Admission H&P, Physician Progress Notes.

IV-4 Was the patient admitted to the ICU following a percutaneous transluminal coronary angioplasty (PTCA), coronary artery stenting, and/or coronary angiography procedure?

Definition Percutaneous Coronary Intervention (PCI) or Percutaneous Transluminal Coronary Angioplasty (PTCA): A catheter-based procedure performed in order to open up an occluded coronary artery and restore blood flow to the heart muscle. Catheterization procedures include:

- Balloon Angioplasty
- Stent placement (Bare metal or Drug Eluting)
- Balloon Angioplasty with Stent Placement
- Balloon Angioplasty and/or Laser Angioplasty
- Directional Coronary Atherectomy (DCA)
- Intravascular Coronary Atherectomy (ICA)

- Rotablator
- Transluminal Extraction Catheterization (TEC)
- Other

Justification MPM II

Instructions

- Indicate whether the patient was in the cardiac catheterization lab immediately before admission to your ICU specifically for the performance of any percutaneous coronary intervention (PCI) or percutaneous transluminal angioplasty (PTCA).
- Do not select "yes" if a patient wan transferred from a cardiac catheterization lab, but did not undergo a percutaneous coronary intervention. Example may include but are not limited to:
  - Right heart cardiac catheterization
  - Placement of an intra-aortic balloon pump
  - Balloon valvuloplasty
  - Intra-cardiac septal ablation
  - Electrophysiologic mapping and/or ablation procedures.
  - Others

Preferred Sources: Transfer notes, H&P, Cardiac Catheterization Report, Physician Progress Note

IV-5 Did the patient have surgery prior to ICU admission?

Definition Surgery is defined as undergoing all or part of a surgical procedure, or anesthesia for a surgical procedure in an operating or anesthesia room even if no other procedure is performed. Does not include medical procedures (e.g. endoscopy, bronchoscopy, cardiac catheterization, interventional radiology…).

- Example: If a patient is taken to the operating room, prepped and draped and has anesthetic delivered, but develops sudden drop in blood pressure requiring admission to the ICU prior to any incision or operative procedure, this would be classified as surgery.

Justification MPM II

Instructions

- Select "Yes" or "No" to indicate whether the patient underwent surgery in the period up to one week before admission to your unit
- A procedure may have been performed in another hospital but must have been within 7 days of admission to your ICU.
- Select "Yes" irrespective of the number of times the patient underwent surgery in the period up to one week before admission to your unit.
- Organ harvesting is not considered surgery.

Preferred Sources: Admission H&P, Intra-operative Anesthesia Record, Postoperative Anesthesia Notes,

Operating Room Record, Surgeon's Operative Note, Recovery Room/PACU Record, Physician Progress Notes

IV-5a If patient had surgery performed prior to admission to unit, was the surgery scheduled or unscheduled?

Definition

- Scheduled surgery is defined as surgery that was scheduled ≥ 24 hours in advance of the operation.
- Unscheduled surgery is defined as any surgery that was NOT scheduled at least 24 hours in advance of the operation.

Justification MPM II

Instructions

- Select the appropriate box to indicate whether the surgery performed within one week prior to this admission to your unit was scheduled or unscheduled.

Preferred Sources: Admission H&P, Intra-operative Anesthesia Record, Postoperative Anesthesia Notes, Operating Room Record, Surgeon's Operative Note, Recovery Room/PACU Record, Physician Progress Notes

IV-5b If patient had an unscheduled surgery, was the surgery an emergent or non-emergent?

Definition

- Emergency surgery is defined as surgery that is scheduled <24 hours in advance AND is immediately required to prevent death, loss of limb or major organ system failure. This is the type of surgery that cannot be delayed for a matter of hours, even to conduct a diagnostic procedure. An emergency surgery is by definition medically required. Examples may include: ruptured aortic aneurysm, CABG in setting of acute coronary syndrome, thrombectomy for pulmonary embolism, vascular surgery for an ischemic limb or bowel, neurosurgery for ruptured aneurysm, etc.
- Non-emergency surgery is a surgery that is scheduled <24 hours in advance and may be delayed for a period of hours in order to apply medical treatments and / or conduct further diagnostic testing. Examples of Non-emergency surgery include
  - Hip replacement due to an acute fracture
  - Surgical procedures for other acute fractures
  - Appendectomy without rupture or sepsis
  - Cholecystectomy without sepsis.
  - Ureteral stone removal without evidence of infection or sepsis
  - Transplant Surgery for chronic end organ disease (Would not include transplant for fulminant hepatic failure).
- Organ harvesting is not emergency surgery.

Justification Risk stratification of unscheduled surgical patients.

Instructions

- Select the appropriate box to indicate whether the unscheduled surgery performed was an emergency surgery or a non-emergency procedure.
- If more than one surgery was performed in the week prior to admission to your unit, enter information pertaining to the most urgent surgery.

Preferred Sources: Admission H&P, Intra-operative Anesthesia Record, Postoperative Anesthesia Notes, Operating Room Record, Surgeon's Operative Note, Recovery Room/PACU Record, Physician Progress Notes

IV-6 Highest Heart Rate within One Hour of Admission to Unit

Definition The highest ventricular rate measured and recorded within one hour before or after admission to the unit.

Justification MPM II

Units Beats per minute

Instructions

- Record the highest ventricular rate measured and recorded within one hour before or after admission to your unit.
- Where no ventricular rate was measurable, enter "000".
- If patient has pacemaker, record the actual ventricular pulse rate, not the rate at which the pacemaker is firing as seen by pacer spikes.
- Ventricular rates should not be recorded during periods of iatrogenic disturbance, for example, physiotherapy, turning, periods of crying etc.
- Values from the operating room are not allowed.

Preferred Sources: ICU Flow Sheet
Other Sources: Physician progress notes, Admission H&P, Nursing notes

IV-7 Lowest Blood Pressure within One Hour of Admission to Unit

Definition The lowest blood pressure value based on the lowest systolic value measured and recorded within one hour before or after admission to the intensive care unit.

Justification MPM II

Units Millimeters of mercury (mmHg)

Instructions

- Record the blood pressure with the lowest systolic value noted within one hour before or after admission to your unit.
- If the patient did not have a measurable systolic blood pressure due to a cardiopulmonary arrest during the hour prior to ICU admission, enter "000/000".
- Blood pressure values should not be recorded during periods of iatrogenic disturbance; for example, physiotherapy, turning, periods of crying etc.
- Blood pressure values are included irrespective of the measurement method used.
- Values from the operating room are not allowed.

Preferred Sources: ICU Flow Sheet
Other Sources: Physician progress notes, Admission H&P, Nursing notes

IV-8 Life Support Status at Admission to the ICU

Definition The patients' and/or families' instructions to the medical team on how to therapeutically proceed should the need for cardiovascular and/or respiratory assistance be needed to sustain one's life. Options include:

- Full code - no restrictions on therapies or interventions
- DNR/No CPR - applies where there is NO chest compression, NO intubation, and NO electrical cardioversion permitted. ALL 3 therapies must be prohibited to choose this category.
- Limited intervention/Withholding therapy - specific limits are in place which either prevent the initiation of a specific therapy or technology and/or prevent further increase of a specific therapy or technology. Includes situations in which dialysis, blood product administration, nutritional support, chemical cardioversion, intubation & other therapies are not to be initiated. Also includes the situation in which it is permitted to do one or two of the interventions listed in the CPR category but not all three.
- Withdrawing therapy/Comfort care - applies to situations in which therapy already in place is being withdrawn or removed. Commonly referred as palliative care in the medical community. This may include any OR all of the following: removal from vent support, removal of pressors, stopping of dialysis and/or stopping of other therapeutic measures. Palliative care includes attention to the psychological and spiritual needs of the patient and support for the dying patient and the patient's family. Comfort Measure Only are not equivalent to the following: Do Not Resuscitate (DNR), living will, no code, no heroic measure.
- Maintenance of circulatory support for organ procurement following determination of brain death.

Synonyms: Code Status

Instructions:

- Select the life support status that best describes the patient's wishes on admission to the ICU.
- Changes in life support status/code status after admission should not be documented with this question.
- If there is no clear documentation of code status, then select full code.

Preferred Sources: Admission History and Physical, Physician Orders, Code Status Documentation

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SECTION V. Acute Diagnoses:

At ICU admission, please indicate any of the following acute medical diagnoses present (Select all that apply).

Cardiac – Arrhythmias / Rhythm Disturbances

Definition Acute cardiac rhythm disturbances as evidenced by an EKG or telemetry tracing. Does not include chronic, stable arrhythmias that have been previously diagnosed and have not changed clinically from previous examinations (e.g. chronic atrial fibrillation / flutter that is rate controlled with HR < 100). Possible arrhythmias include:

- Atrial fibrillation / flutter with rapid ventricular response (HR ≥ 100)
- Other supraventricular: SVT / PSVT / WPW
- 2nd degree or 3rd degree heart block
- Ventricular tachycardia / fibrillation
- Other rhythm disturbance, not chronic / not stable

Justification MPM II

Instructions

- Select box if on admission pt with acute arrhythmia.
- Do not select box for cardiac arrhythmias / rhythm disturbances for chronic and stable arrhythmias (i.e. chronic stable atrial fibrillation with HR < 100)
- If pt in chronic atrial fibrillation at baseline, but HR now > 100 then select this box.
- Do not select box for sinus tachycdia

Preferred Sources: Current Admission Notes, Physician progress notes, Consultation Notes, EKG reports.

Cardiac Surgery – Patient Admitted to ICU After Cardiac Surgery

Definition Includes any surgical procedure, under general anesthesia, that involves any structure of the heart and/or aorta. Does not include cardiac catheterization procedures or electrophysiological procedures (e.g. coronary artery stent placements, coronary artery balloon angioplasty,

pacemaker placement, defibrillator placement). Examples of cardiac surgical procedures include:

- Abdominal aortic aneurysm surgery (including dissection / rupture)
- Thoracic aortic aneurysm surgery (including dissection / rupture)
- Atrial Septal Defect (ASD) Repair
- Coronary Artery Bypass Surgery (including redo or with valve)
- Complications of previous open-heart surgery, surgery for (e.g. bleeding, infection, mediastinal rewiring, leaking aortic graft etc.)
- Congenital defect repair
- Embolectomy (with general anesthesia)
- Pericardiectomy (total/subtotal)
- Thrombectomy (with general anesthesia)
- Tumor removal, intra-cardiac
- Valve repair and/or replacement
- Valve anuloplasty
- Ventricular Septal Defect (VSD) Repair

Justification MPM II

Instructions

- ❑ Select box if pt admitted to ICU following a cardiac surgery.
- ❑ Do not mark for Electrophysiology Procedures (Pacemaker placement, defibrillator placement, radiofrequency ablation / mapping, etc..)
- ❑ Do not mark for any procedure performed in the cardiac catheterization lab (coronary angiography, coronary angioplasty, coronary stent placement, atrial septal defect repair via catheterization, alcohol septal ablation, etc.)
- ❑ Do not mark for vascular procedures not including the aorta (Subclavian vessel, carotid arteries, inferior vena cava)

Preferred Sources: Current Admission Notes, , Physician progress notes, Operative Reports, Consultation Notes,

Gastrointestinal Bleeding

Definition Defined as clinical evidence of gastrointestinal bleeding that may include hematemesis, "coffee grounds emesis", melena, or bright red blood per rectum. May be identified by clinical observation or via a nasogastric tube placement. May also be diagnosed via an upper endoscopy or colonoscopy. A drop in hematocrit or perforated ulcer alone is NOT sufficient to qualify as an acute diagnosis of GI bleeding. Gastrointestinal bleeding may include.

- Upper GI bleed from esophageal varices or portal hypertension
- Upper GI Bleed: Includes any clinical evidence of hematemesis, coffee grounds emesis, or melena (Actual underlying diagnosis not required).

Diagnoses may include: Bleeding peptic ulcer, gastric ulcer, Mallory Weiss tear, gastric erosions, hemoscuccus pancreaticus, etc.
- Lower GI Bleed, other: Would include any evidence of bright red blood per rectum. Diagnoses may include: Diverticular bleed, angiodysplasia, colonic ischemia, etc.
- GI Bleed, unknown source (Bleeding is clinically apparent from the gastrointestinal tract yet the source definitive source is unknown).

Justification MPM II

Instructions
- ❑ Select box if pt with acute diagnosis of gastrointestinal bleed at the time of admission to the ICU. .
- ❑ Select box if GI bleed identified by clinically evident hematemesis (vomiting bright red blood), coffee ground emesis (vomiting coffee ground appearing gastric contents), melena (dark, black, tarry, malodorous stools that are Guaiac positive), or bright red blood per rectum.
- ❑ A guaiac positive stool without clinically observed bleeding is insufficient to make the diagnosis.
- ❑ A hemoglobin drop is not sufficient evidence of acute GI bleeding
- ❑ A perforated ulcer does not necessarily indicate GI bleeding

Preferred Sources: Current Admission Notes, Physician progress notes, Endoscopy Reports, Emergency Room Notes, Nursing Notes, Consultation Notes,

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Sepsis

Definition A severe systemic response to an infection. There **Must** be clinical or microbiological evidence of an infection (e.g. meningitis, pneumonia, pyelonephritis, endocarditis, gastroenteritis). May or may not have bacteremia. Does not include inflammatory response due to non-infectious pancreatitis, end organ ischemia, multiple trauma and tissue injury. In the presence of clinical and / or microbiological evidence of an infectious source, must also include at least two of the following.
- Temperature: greater than 38°C or less than 36°C
- Heart rate: greater than 90 beats per minute
- Respiratory rate: greater than 20 breaths per minute or $PaCo_2$ less than 32 mm Hg
- White blood cells: greater than 12,000 cells per µL or less than 4000 cells per µL or greater than 10% immature (band) forms

Justification Important for assessing risk of patients admitted to ICU and determination of case-mix.

Instructions
- ❑ Select box if a patient is admitted with a diagnosis of sepsis
- ❑ Do not select if there is no clinical or microbiological evidence of infection

- Do not select if systemic inflammatory response is secondary to trauma, tissue injury, pancreatitis (unless believed infectious), or other non-infectious entity.

Preferred Sources: Current Admission Notes, Physician progress notes, Laboratory Reports, Emergency Room Notes, Nursing Notes, Consultation Notes,

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Renal

Definition A group of diseases that may be associated with decreased GFR and manifested by retention of BUN and creatinine. Acute renal failure is defined as a rapidly (over a period of days) increasing creatinine level or decreasing urine output. Any of the following criteria would qualify as acute renal failure.

- Creatinine levels that is > 2 times the baseline creatinine level
- Glomerular filtration rate needs to be reduced by 50%.
- Sudden drop in urine output less than 5ml / kg / h over a period of 12 hours.
- Documentation by physician of acute renal failure.

The possible types of renal failure include:

- *Acute renal failure / acute on chronic renal failure, Prerenal***:** Renal dysfunction due to diseases that decrease temporarily arterial blood supply to the kidney. Examples include: Hypovolemia (vomiting, diarrhea, diuretics), CHF, liver failure, and renal arterial stenosis (RAS). Common diagnostic characteristic of pre-renal failure include the following: (Note none of the following by themselves are diagnostic of pre-renal failure)
  - Pre-renal disease is usually reversible once the underlying etiology of the disease is reversed. If the damage to the kidney is irreversible, it is less likely due to pre-renal etiologies.
  - Urinalysis typically reveals a normal urinary sediment without hemoglobin, protein, cells.
  - The BUN to Creatinine Ratio is typically > 20
  - Urine indices that suggest prerenal ARF include the following:
    - Urine specific gravity >1.018
    - Urine osmolality (mOsm/kg H_2O) >500
    - Urine sodium (mEq/L) <15-20
    - Urine/plasma creatinine ratio >40
  - FeNa = (urine Na/plasma Na)/(urine creatinine/plasma creatinine) FeNa <1 % = prerenal ARF
  -

- *Acute renal failure / acute on chronic renal failure, Not Prerenal***:** Renal dysfunction due to diseases of the renal parenchyma, specifically involving the renal tubules, glomeruli, interstitium. Renal dysfunction also includes dysfunction due to postrenal failure, or diseases causing urinary obstruction from the level of the renal tubules to the urethra. Intrinsic and Postrenal processes include:

- Acute Tubular Necrosis (ATN): One of the most common causes of renal failure in ICU patients. Any form of pre-renal failure may lead to ATN if severe or prolonged enough to cause tubular cell death.
- Ischemia, toxins (e.g., aminoglycosides, radiocontrast, heme pigments, cisplatin, myeloma light chains, ethylene glycol)
- Interstitial diseases - Acute interstitial nephritis, drug reactions, autoimmune diseases (e.g., systemic lupus erythematosus [SLE]), infiltrative disease (sarcoidosis, lymphoma), infectious agents (Legionnaire disease, hantavirus.
- Acute glomerulonephritis
- Vascular diseases - Hypertensive crisis, polyarteritis nodosa, Vasculitis
- Tubular obstruction from crystals (e.g., uric acid, calcium oxalate, acyclovir, sulfonamide, methotrexate, myeloma light chains)
- Ureteral obstruction - Retroperitoneal tumor, retroperitoneal fibrosis (methylsergide, propranolol, hydralazine), urolithiasis, papillary necrosis
- Urethral obstruction - Benign prostatic hypertrophy; prostate, cervical, bladder, colorectal carcinoma; bladder hematoma; bladder stone; obstructed Foley catheter; neurogenic bladder; stricture
- Common diagnostic characteristics of acute renal failure that is not prerenal include: (Note none of the following by themselves are diagnostic).
  - Urinalysis may be normal or reveal any of the following:
    - Muddy-Brown Casts.
    - Granular Casts
    - Hemoglobinuria
    - Proteinuria
    - RBC casts or WBC casts
    - Crytals
    - Dysmorphic red cells.
  - The BUN to Creatinine Ratio is typically < 20.
  - Urine indices that suggest NON prerenal ARF include the following:
    - Urine sodium (mEq/L) >40
    - Urine/plasma creatinine ratio <20
    - FeNa = (urine Na/plasma Na)/(urine creatinine/plasma creatinine) FeNa >1% = ATN

Justification MPM II

Instructions

- ❑ Select box if pt with diagnosis of acute renal failure at admission to ICU.
- ❑ Do not select box if there is only evidence of chronic renal failure.

- Do not select box unless there is prior historical or laboratory documentation of baseline renal function in which to compare the current creatinine, GFR, or urine output. (In other words due not select as acute renal failure unless it is known that this is worse compared to baseline).
- If do not know etiology of the acute renal failure select "Unknown Type"

Preferred Sources: Current Admission Notes, Physician progress notes, Laboratory Reports, Emergency Room Notes, Nursing Notes, Consultation Notes,

Neurologic – Coma or Deep Stupor

Definition Coma: No response to any stimulation, no twitching, no movement in extremities, no response to pain or command**.** Deep Stupor: Exhibits decorticate or decerebrate posturing, posturing is spontaneous or in response to stimulation or deep pain, not in response to commands. Possible causes of Coma / Deep stupor include

- Traumatic Injury
- Medical, non-traumatic: Includes hepatic encephalopathy, metabolic Encephalopathies, stroke, intracerebral hemorrhage, anoxic brain injury, etc.)
- Drug Overdose

Justification MPM II

Instructions

- Select box if pt with diagnosis coma or deep stupor at admission to ICU.
- For patients taking a paralyzing muscle relaxant, awakening from anesthesia, or heavily sedated, use your best judgment of the level of consciousness prior to sedation.

Preferred Sources: Current Admission Notes, Physician progress notes, Emergency Room Notes, Nursing Notes, Consultation Notes,

Neurologic – Cerebrovascular Incident

Definition Any acute cause of a stroke and / or bleed involving the brain or deep brain structures (e.g. pons, midbrain, cerebellum), or structures surrounding the brain (dural space). Possible causes include:

- Arteriovenous malformation with subarachnoid hemorrhage or stroke.
- Cerebrovascular accident / CVA / stroke (emobolic and/or thrombotic)
- Epidural hematoma
- Subarachnoid hemorrhage / intracranial aneurysm (bleeding)
- Subdural hematoma
- Intracranial hemorrhage / hematoma, other

Justification MPM II

Instructions

- Select box if pt with diagnosis coma or deep stupor at admission to ICU.
- Does not include chronic arteriovenous malformation
- Does not include chronic cerebral aneurysm
- Do not include chronic epidural / subdural bleed.

Preferred Sources: Current Admission Notes, Physician progress notes, Emergency Room Notes, Nursing Notes, Consultation Notes, Radiology Reports

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SECTION VI. MEDICAL HISTORY

Does the patient have any of the following medical conditions / treatments that have been diagnosed, symptomatic, or ongoing in the six months prior to admission? (Select all that apply).

Confirmed Cirrhosis

Definition Cirrhosis is a progressive, irreversible disease of the liver characterized by diffuse damage to hepatic parenchymal cells, with nodular regeneration, fibrosis, and disturbance of normal architecture; associated with failure in the function of hepatic cells and interference with blood flow in the liver, frequently resulting in jaundice, portal hypertension, ascites, and ultimately hepatic failure. Confirmed cirrhosis includes cirrhosis that is confirmed by biopsy, endoscopy, or an imaging study such as CT, US, or MRI.

Justification MPM II

Instructions

- Check box if the PMH indicates confirmed cirrhosis
- Confirmed cirrhosis includes cirrhosis that is confirmed by biopsy, endoscopy, or an imaging study such as CT, US, or MRI.
  - Please indicate if method of diagnosis know, biopsy proven vs. clinical / imaging based diagnosis.
- If cirrhosis is diagnosed on this admission, then this should count as a chronic health variable as was likely present prior to admission.
- If the patient has a functioning liver transplant, this chronic health variable does not apply.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Current or past Admission Notes, Discharge Summaries, Pathology Report, Physician/nurses' emergency room notes, Physician progress notes, Operative Reports, Radiology Reports.

Portal Hypertension prior to ICU admission

Definition — Seen most frequently in patients with liver disease, such as cirrhosis or hepatitis, portal hypertension is a condition in which the normal flow of blood through the liver is slowed or blocked by scarring or other damage. Patients with the condition are at risk of variceal bleeding or other life-threatening complications.

Justification — MPM II

Instructions

- Check box if the PMH documents portal hypertension. Evidence of portal hypertension includes:
  - Esophageal or gastric varices demonstrated by surgery, imaging, or endoscopy.
  - Portal hypertensive gastropathy demonstrated by surgery, imaging (ultrasonography, CT scan, MRI, or endoscopy.
  - Retrograde splenic-venous flow or hepatofugal flow on any imaging procedure (example: ultrasonography, MRI)
  - Direct hemodynamic measurement of portal pressure via femoral or internal jugular vein catheter. Measurement of the hepatic venous pressure gradient (HVPG).
  - Prior history of transjugular intrahepatic portosystemic shunt (TIPS) procedure or porto-systemic shunt surgery.
  - History of ascites that is documented by physician to be secondary to portal hypertension.
- Do not include gastrointestinal bleeding without evidence of portal hypertension.
- Do not include history of ascites without evidence of portal hypertension.
- If portal hypertension is diagnosed on this admission, then this should count as a chronic health variable as was likely present prior to admission.
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- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

Jaundice AND Ascites prior to ICU admission

Definition — Jaundice is a yellowish staining of the skin, sclera, and mucous membranes by bilirubin which may rise in patients with acute or chronic liver disease. The discoloration typically is detected clinically once the serum bilirubin level rises above 3 mg per dL (51.3 μmol per L).

Ascites is the presence of excess fluid in the peritoneal cavity. It is a common clinical finding with a wide range of causes, but develops most

frequently as a part of the decompensation of previously asymptomatic chronic liver disease.

Justification MPM II

Instructions

- Check box if there is prior documented medical history indicating the simultaneous presence of jaundice and ascites in the past 6 months.
- Ascites may be diagnosed by imaging (ultrasonography, CT scan, MRI), prior history of ascites visualized either during surgery, or with an abdominal paracentesis.
- Physical examination alone for ascites is not adequate to make diagnosis of ascites. There must also be supporting imaging evidence (ultrasonography, CT scan, or MRI), or prior history of fluid visualized during surgery or with an abdominal paracentesis.
- Physical examination alone is not adequate to make diagnosis of jaundice. Serum bilirubin level must be ≥ 3mg/dL (51.3 µmol/L) to clinically visualize jaundice.
- Do not check box unless jaundice and ascites are believed to be secondary to cirrhosis.
- Do not check box if there is only documentation of jaundice alone.
- Do not check box if there is only documentation of ascites alone.
- If the patient has a functioning liver transplant, this chronic health variable does not apply.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

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GI Bleeding attributed to Portal Hypertension prior to ICU admission

Definition Bleeding from ruptured dilated gastric or esophageal veins due to portal hypertension in the setting of cirrhosis.

Justification MPM II

Instructions

- Check box if the PMH indicates episode(s) of variceal bleeding prior to admission to your unit.
- Do not include history of upper GI bleed unless specifically documented that bleed is variceal in nature.
- Do not include history of variceal bleeding unless patient meets criteria for cirrhosis.
- If GI bleed attributable to portal hypertension is diagnosed on this admission, then this should count as a chronic health variable as the portal hypertension was likely present prior to admission.

- If the patient has a functioning liver transplant, this chronic health variable does not apply.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

Hepatic Encephalopathy and/or Hepatic Coma prior to ICU admission

Definition A syndrome observed in patients WITH cirrhosis of the liver. It is characterized by personality changes, intellectual impairment, and a depressed level of consciousness. Grades of hepatic encephalopathy include:

- Grade 0 No abnormality detected.
- Grade 1 Slowness in cerebration, intermittent mild confusion and euphoria.
- Grade 2 Confused most of the time, increasing drowsiness.
- Grade 3 Severe confusion, arousable, responds to simple commands.
- Grade 4 Unconscious, responds to painful stimuli.

Justification MPM II

Instructions

- Check box if the PMH indicates episodes of hepatic encephalopathy, Grade 1 or greater, in the six months prior to admission to your unit.
- There is no need to figure out the grade. The grading system is presented to assist you in determining if there is encephalopathy. Patient would have exhibited slow thinking, euphoria, confusion, drowsiness, or altered consciousness.
- Do not include history of hepatic encephalopathy unless patient meets criteria for cirrhosis and / or portal hypertension.
- If the patient has a functioning liver transplant, this chronic health variable does not apply.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

Renal Dysfunction without Dialysis but Creatinine > 2.0mg/dL prior to ICU admission

Definition Specifies whether the patient currently has chronic kidney disease with a baseline creatinine chronically greater than 2.0 mg/dL *prior to this admission to the hospital,* for ≥ 3 months.

Justification MPM II

Instructions

- ❑ Check box if the PMH indicates chronic renal insufficiency or dysfunction with a baseline creatinine chronically greater than 2.0 mg/dL *prior to this admission to the hospital,* for ≥ 3 months.
- ❑ If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

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Chronic Renal Replacement Therapy (Dialysis) prior to ICU admission

Definition Renal replacement therapy (dialysis) is a process of purifying and adding nutrients into the blood through artificial means for irreversible kidney damage. There are two primary methods of dialysis. Hemodialysis is where the patient's blood is removed from an artery, purified through a dialysis machine, and then returned into a vein along with added nutrients. Peritoneal dialysis is where the peritoneum (the membrane lining the abdominal cavity) is used to filter the blood. Chronic is defined as ≥ 3 months.

Inclusions Chronic hemodialysis (HD), Chronic peritoneal dialysis, Chronic renal dialysis, Continuous peritoneal dialysis, ESRD with evidence of chronic dialysis treatment.

Exclusions Dialysis for current acute renal failure without a history of chronic renal disease and/or dialysis < 3 months duration.

Justification MPM II

Instructions

- ❑ Check box if the PMH indicates current renal replacement therapy for irreversible renal disease.
- ❑ Do not include patients who are status post kidney transplant that no longer need dialysis.
- ❑ If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

Metastatic Disease within 6 months prior to admission to the ICU

Definition The patient has distant (not regional lymph node) metastasis of a solid tumor documented by surgery, imaging or biopsy, and evident in the six months prior to admission to the unit.

Justification MPM II

Instructions

- Check box if the PMH indicates that the patient has distant (not regional lymph node) metastases, evident in the six months prior to admission to the unit, and documented as a metastasis in the note or by surgery, imaging, biopsy, or clinical assessment.
- This does not include hematologic malignancies (Examples. Chronic lymphocytic leukemia, chronic myelogenous leukemia, acute lymphocytic leukemia, acute myelogenous leukemia, multiple myeloma, polycythemia vera, essential thrombocytosis, Waldenstrom's).
- Metastatic melanoma is considered a metastatic solid organ malignancy.
- If metastatic disease is diagnosed on this ICU admission, then this should count as a chronic health variable as was likely present prior to admission.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Pathology Reports, Operative Report, Radiology Results, Discharge Summary, Physician's H&P/admission Notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes, Oncology Notes

Chronic myelogenous leukemia or chronic lymphocytic leukemia with associated treatment and/or complications attributable to the disease

Definition Specifies whether the patient has chronic myelogenous leukemia(CML) or chronic lymphocytic leukemia(CLL) evident in the six months prior to admission to the intensive care unit AND has either received chemotherapy for the disease, or experienced complications attributable to the disease. Complications include: Sepsis, anemia, "blast crisis", stroke caused by clumping of white blood cells, tumor lysis syndrome, pulmonary edema including lymphangiectatic form or ARDS.

Justification MPM II

Instructions

- Check box if the PMH indicates that the patient has chronic myelogenous leukemia(CML) or chronic lymphocytic leukemia(CLL) evident in the six months prior to admission to the unit and has either received chemotherapy or experienced complication attributable to the disease.
- Do not check box if patient has CML and/or CLL and has not undergone treatment, or experienced complications attributable to the disease in the 6 months previous to ICU admission.

- If chronic leukemia is diagnosed on this ICU admission, then this should count as a chronic health variable as was likely present prior to admission.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes

Acute myelogenous leukemia, acute lymphocytic leukemia, multiple myeloma, or other acute hematologic malignancy in 6 months prior to ICU admission

Definition The patient has a history of acute or chronic myelogenous or lymphocytic leukemia, or multiple myeloma evident in the six months prior to admission to the intensive care unit.

Justification MPM II

Instructions

- Check box if the PMH indicates that the patient has acute myelogenous leukemia, acute lymphocytic leukemia or multiple myeloma evident in the six months prior to admission to the unit.
- Check box regardless of history of treatment or complications attributable to the disease.
- If acute leukemia is diagnosed on this ICU admission, then this should count as a chronic health variable as was likely present prior to admission.
- Check this box for all other acute hematologic malignancies. Examples may include Hairy Cell Leukemia, Waldenstrom's Macroglobulinemia, and Acute Granulocytic Leukemia.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Discharge Summary; Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes, Oncology Notes

Lymphoma in 6 months prior to ICU admission

Definition Specifies whether the patient has lymphoma, documented by surgery, imaging or biopsy, and evident in the six months prior to admission to the unit. Lymphoma type may be of the Hodgkin's or Non-Hodgkin's type. Hodgkin's disease is a type of lymphoma described by Thomas Hodgkin in 1832, and characterized by the presence of Reed-Sternberg cells.

Justification MPMII

Instructions

- Check box if the PMH indicates that the patient has lymphoma, documented by surgery, imaging or biopsy, and evident in the six months prior to admission to your unit.
- Check box if PMH indicates that lymphoma is Hodgkin's, Non-Hodgkin's or unknown.
- Check box regardless of history of treatment or complications attributable to the disease.
- If lymphoma is diagnosed on this ICU admission, then this should count as a chronic health variable as was likely present prior to admission.
- If this information is not available on admission, but becomes available at a later date, it should be updated.

Preferred Sources: Pathology Report, Operative Report, Radiology Results, Discharge Summary, Physician's H&P/admission notes, Physician/nurses' Emergency Room Notes, Physician Progress Notes, Oncology Notes

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SECTION VII. MENTAL STATUS

VII-1 Glasgow Coma Score at admission to the ICU

Definition The Glasgow Coma Scale is a scoring instrument used to quantify depth and duration of impaired consciousness based on a patient's eye opening, verbal performance, and motor responsiveness.

Justification MPMII.

Instructions

- Enter total Glasgow Coma Score at admission to the intensive care unit.
- The total Glasgow Coma Score must equal the sum of the associated eye, motor and verbal components, further defined below.
- All three components of the Glasgow coma score (eyes, verbal and motor) must be documented at the same time.
- A GCS score at admission is required, thus for patients under the effects of paralytic or sedative medications use your best clinical judgment to estimate the patient's GCS at the time prior to initiation of sedation / paralytic agents.
  - Estimates while on sedative medications are allowed as long as it is not thought to alter the patient's level of consciousness. (Example. A patient on a patient controlled analgesia (PCA) pump with rare boluses should still have a Glasgow Coma Score assessed.)
  - By definition, the patient's level of consciousness is not lowered by the medications if patient has a score of 15 while on sedation / pain medications.
- For surgical patients who return from the operating room sedated and/or paralyzed, the patient's GCS immediately prior to surgery should be recorded as the estimate.

- Patients with an ICU admitting diagnosis of self-inflicted overdose(OD) should have their actual Glasgow coma score determined because the sedation is part of the pathology of an OD.

Preferred Sources: Admission H&P, Physician Progress Notes, Physician/Nurse ER record, Nursing Notes, ICU Flowsheet, Neurology Consultation Notes

VII-1 Associated Eye Opening Response from Admission Glasgow Coma Score

Definition The eye opening response is one of three components of the total Glasgow Coma Score (GCS). Eye opening response is scored on a scale from 1 to 4. The values correspond to the following:

1. No eye response to any stimuli
2. Eye opening to pain only
3. Eye opening to verbal command
4. Spontaneous eye opening

Justification MPMII.

Instructions

- Enter the eye component associated with the total Glasgow Coma Score at admission to your intensive care unit.
- A GCS score at admission is required, thus for patients under the effects of paralytic or sedative medications use your best clinical judgment to estimate the patient's GCS as close to the time prior to initiation of sedation / paralytic agents.
  - Estimates while on sedative medications are allowed as long as it is not thought to alter the patient's level of consciousness. (Example. A patient on a patient controlled analgesia (PCA) pump with rare boluses should still have a Glasgow Coma Score assessed.)
- For surgical patients who return from the operating room sedated and/or paralyzed, the patient's GCS immediately prior to surgery should be recorded as the estimate.
- Patients with an ICU admitting diagnosis of self-inflicted overdose(OD) should have their actual Glasgow Coma Score determined because the sedation is part of the pathology of an OD.
- If lowest total Glasgow Coma Score equals 3, the associated eye can be automatically entered as 1.
- If lowest total Glasgow Coma Score equals 15, the associated eye component value can be automatically entered as 4.

Preferred Sources: Admission H&P, Physician Progress Notes, Physician/Nurse ER record, Nursing Notes, ICU Flowsheet, Neurology Consultation Notes

VII-1 Associated Motor Component from Admission Glasgow Coma Score

Definition The motor response is one of three components of the total Glasgow Coma Score (GCS). Motor response is scored on a scale from 1 to 6. The values correspond to the following:

1. No response
2. Extension/decerebrate rigidity
3. Flexion-abnormal/decorticate rigidity
4. Flexion-withdrawal
5. Localizes pain
6. Obeys (moves according to) verbal command

Justification MPM II.

Instructions

- Enter the motor component associated with the total Glasgow Coma Score at admission to your intensive care unit.
- A GCS score at admission is required, thus for patients under the effects of paralytic or sedative medications use your best clinical judgment to estimate the patient's GCS as close to the time prior to initiation of sedation / paralytic agents.
  - Estimates while on sedative medications are allowed as long as it is not thought to alter the patient's level of consciousness. (Example. A patient on a patient controlled analgesia (PCA) pump with rare boluses should still have a Glasgow Coma Score assessed.)
- For surgical patients who return from the operating room sedated and/or paralyzed, the patient's GCS immediately prior to surgery should be recorded as the estimate.
- Patients with an ICU admitting diagnosis of self-inflicted overdose (OD) should have their actual Glasgow coma score determined because the sedation is part of the pathology of an OD.
- If lowest total Glasgow Coma Score equals 3, the associated motor component can be automatically entered as 1.
- If lowest total Glasgow Coma Score equals 15, the associated motor component value can be automatically entered as 5.

Preferred Sources: Admission H&P, Physician Progress Notes, Physician/Nurse ER record, Nursing Notes, ICU Flowsheet, Neurology Consultation Notes

VII-1 Associated Verbal Component from Admission Glasgow Coma Score

Definition The verbal response is one of three components of the total Glasgow Coma Score (GCS). Verbal response is scored on a scale from 1 to 6. The values correspond to the following:

1. No response, OR if patient intubated or unable to speak, patient is clearly unresponsive
2. Incomprehensible sounds – not words
3. Inappropriate words, OR if patient intubated or unable to speak, patient is responsive but orientation and ability to communicate reasonably are in question
4. Disoriented and converses
5. Oriented and converses, OR if patient intubated or unable to speak, patient is clearly oriented and able to converse or indicate needs

Justification MPM II

Instructions

- Enter the verbal component associated with the total Glasgow Coma Score at admission to your intensive care unit.
- If the patient is unable to speak or vocalize for any reason, such as aphasia, Parkinsonism, intubation, or foreign language barrier, use your clinical judgment to assess the patient's actual ability to communicate and assign verbal scores according to the modified verbal score.
  - An example of this is the patient who is intubated, but clearly follows all verbal commands accurately. This is evidence that the patient understands verbal communication. If the patient nods appropriately to questions asked, it is apparent that he or she understands and is attempting to communicate. These are also those patients that write notes such as "What time is Jeopardy on?" Therefore, even a patient who cannot verbalize, it is clear that they are still able to communicate and normal verbal score of 5 should be assigned. Similarly, if the patient is able to follow commands, but you are unsure of orientation, assign a verbal score of 3. Only those patients that are clearly unresponsive should have a score of 1 assigned.
- A GCS score at admission is required, thus for patients under the effects of paralytic or sedative medications use your best clinical judgment to estimate the patient's GCS as close to the time prior to initiation of sedation / paralytic agents.
  - Estimates while on sedative medications are allowed as long as it is not thought to alter the patient's level of consciousness. (Example. A patient on a patient controlled analgesia (PCA) pump with rare boluses should still have a Glasgow Coma Score assessed.)
- For surgical patients who return from the operating room sedated and/or paralyzed, the patient's GCS immediately prior to surgery should be recorded as the estimate.
- Patients with an ICU admitting diagnosis of self-inflicted overdose(OD) should have their actual Glasgow coma score determined because the sedation is part of the pathology of an OD.
- If lowest total Glasgow Coma Score equals 3, the associated verbal component can be automatically entered as 1.

- If lowest total Glasgow Coma Score equals 15, the associated verbal component value can be automatically entered as 6.

Preferred Sources: Admission H&P, Physician Progress Notes, Physician/Nurse ER record, Nursing Notes, ICU Flowsheet, Neurology Consultation Notes

VII-1a Is GCS Physician/Nurse documented or Estimated Score?

Definition Physician or nurse documented requires that the evaluation of the neurologic status was derived from any form of nursing or physician documentation of the patient's mental status. This is not limited to a GCS score, and includes statements such as: Opens eyes to my commands, Moves all extremities to pain, Speaking but disoriented, etc.

Justification Data Quality Assessment.

Instructions

- Select whether the GCS recorded at admission was derived from explicit neurologic descriptors from nursing / physician notes, or estimated using your best clinical judgment.

Preferred Sources: Admission H&P, Physician Progress Notes, Physician/Nurse ER record, Nursing Notes, ICU Flowsheet, Neurology Consultation Notes

VII-2 Was the patient's level of consciousness significantly depressed due to the effects of sedative or paralytic agents at ICU admission?

Definition At ICU admission a patient's ability to verbally or non-verbally interact is limited due to the administration of medications that may include sedative agents, analgesic agents, anesthetic agents, and paralytic agents.

The following is a listing of common sedative medications:

Alprazolam	Haldol
Amidate	Haloperidol
Ativan	Inapsine
Brevital	Ketalar
Clonazepam	Ketamine
Chlordiazepoxide	Klonopin
Chlorpromazine	Librium
Dexmedetomidine	Lorazepam
Diazepam	Methohexital
Diprivan	Midazolam
Droperidol	Niravam
Estazolam	Oxazepam
Etomidate	Pentothal
Halcion	Precedex

The following is a listing of common analgesic medications:

Alfenta
Alfentanil
Buprenex
Buprenorphine
Butorphanol
Dalgan
Demerol
Dezocine
Dilaudid
Duragesic
Fentanyl
Hydromorphone
Morphine
Meperidine
Methadone
Nalbuphine
Nubain
Palladone
Pentazocine
Remifentanil
Stadol
Sublimaze
Sufenta
Sufentanil
Talwin
Ultiva

The following is a list of common paralytic medications:

Anectine
Atracurium
Cistracurium
Curare
Doxacurium
Metocurine
Mivacron
Mivacurium
Nimbex
Norcuron
Nuromax
Pancuronium
Pavulon
Pipecuronium
Rapacuronium
Rocuronium
Succinylcholine
Tracrium
Tubocurarine
Vecuroniumr
Zemuron

Justification MPM II

Instructions

- Use your best clinical judgment to determine whether the patient's level of consciousness is significantly depressed at the time of ICU admission.
- This does not include if a patient is receiving sedative medications, but the patient's level of consciousness is judged not to be significantly depressed by the medications. (Example. A patient on a patient controlled analgesia (PCA) pump with rare boluses should still have a Glasgow Coma Score assessed.)
- Select "No" if at any time the patient had a GCS score of 15 in the 12 hours prior to admission, regardless of the sedative or analgesic agents the patient may have been on at the time of GCS assessment.
- Select "No" for patients with an ICU admission diagnosis of self-inflicted overdose (OD).
- Select "Yes" for a surgical patient who returns from the operating room sedated and/or paralyzed.

Preferred Sources: Admission H&P, Physician Progress Notes, Physician/Nurse ER record, Nursing Notes, ICU Flowsheet, Neurology Consultation Notes

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SECTION VIII. DISCHARGE

VIII-1 Date of Discharge from your ICU Unit

Definition The month, day, and year the patient was physically discharged from the intensive care unit, left against medical advice, or expired during this ICU stay.

Justification The date of admission to your unit and time of admission to your unit and date of discharge from your unit and time of discharge from your unit are used to calculate length of stay in your unit. Date of discharge from your unit and date of discharge from hospital are used to calculate days in hospital after discharge from your unit.

Instructions

- Enter the month, day, and year that the patient was discharged from this admission to your unit, left against medical advice, or expired.
- The date of discharge from your unit is the latest documented date of the patient being physically in your unit.
- Discharge does not include temporary transfer from your unit, for example, either for surgery, radiology, medical procedures, other investigation or to the recovery room due to pressure on beds in the expectation of a return to your unit.

- Discharge to the recovery room, with no expectation of returning to your unit, is considered as physical discharge from your unit.

Preferred Sources: Nursing Discharge Notes, ICU Flow Sheet
Other Sources: Physician orders, Physician Progress Notes, Transfer Notes.

VIII-1 Time of Discharge from Unit

Definition The time (military) the patient was discharged from the intensive care unit, left against medical advice (AMA), or expired during this ICU admission.

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Justification Date of admission to your unit and time of admission to your unit and date of discharge from your unit and time of discharge from your unit are used to calculate length of stay in your unit.

Instructions

- Enter the time of the day that the patient was discharged from this admission to your unit in hh:mm (military) format
- Discharge from your unit is defined as the physical discharge and recording of that discharge from a bed in your unit.
- Time of discharge from your unit is the latest documented time of the patient being physically within your unit.

Military Time

HH = Hour (00-23)
MM = Minutes (00-59)

Military Time – A 24-hour period from midnight to midnight using a 4-digit number of which the first two digits indicate the hour and the last two digits indicate the minute.

Converting clock time to military time:
With the exception of Midnight and Noon:

* If the time is in the a.m., conversion is not required.
* If the time is in the p.m., add 12 to the clock time hour.

For example:

Midnight – 00:00	Noon – 12:00
5:31 am – 05:31	5:31 pm – 17:31
11:59 am – 11:59	11:59 pm – 23:59

Preferred Sources: ICU Flow Sheet, Nursing Discharge Notes
Other Sources: Physician orders, Physician Progress Notes, Transfer Notes.

VIII-2 Date of Discharge from your Hospital

Definition The month, day, and year the patient was discharged from acute care, left against medical advice, or expired during this acute care hospital stay.

Justification Date of discharge and date of admission to your hospital are used to calculate length of stay in your hospital.

Instructions

- Enter the date the patient was discharged from your hospital.
- A four-digit year must be entered.
- The date of discharge is the latest documented date of the patient being physically in a bed in your acute care hospital.
- If transferred to a rehabilitation unit, or skilled nursing unit in your same hospital, document this date as the discharge date.

Preferred Sources: Discharge Summary, Nursing Discharge Notes, Physician Orders
Other Sources: Physician Progress Notes, Transfer note

VIII-2 Time of Discharge from Hospital

Definition The exact time (military time) represented in hours and minutes, at which the patient was discharged from inpatient care.

Justification Date of admission to your hospital and time of admission to your hospital and date of discharge from your hospital and time of discharge from your hospital are used to calculate length of stay in your hospital.

Instructions

- Enter the time of the day that the patient was discharged from this admission to your hospital.
- Time of discharge from your hospital is the latest documented time of the patient being physically within your hospital.
- If transferred to a rehabilitation unit, or skilled nursing unit in your same hospital, document this date as the discharge date.
- Enter the hour and minutes the patient was discharged from your hospital in hh:mm (military) format.

Military Time HH = Hour (00-23)
MM = Minutes (00-59)

Military Time – A 24-hour period from midnight to midnight using a 4-digit number of which the first two digits indicate the hour and the last two digits indicate the minute.

Converting clock time to military time:

With the exception of Midnight and Noon:

* If the time is in the a.m., conversion is not required.
* If the time is in the p.m., add 12 to the clock time hour.

For example:

Midnight – 00:00	Noon – 12:00
5:31 am – 05:31	5:31 pm – 17:31
11:59 am – 11:59	11:59 pm – 23:59

Preferred Sources: Discharge Summary, Nursing Discharge Notes, Physician Orders
Other Sources: Physician Progress Notes, Transfer note

VIII-3 Status of Patient at Discharge from ICU Unit

Definition The physical condition of the patient at discharge from your intensive care unit.

Justification Required for survival statistics

Instructions

- Select one of the following to indicate if the patient was alive when discharged from your unit.
  - Stable - patient's condition improving or without significant change. Does not require intensive intervention.
  - Heart still beating but under consideration for organ donation.
  - Discharged for comfort care with no expectation of recovery.
  - Dead (includes admissions who leave your unit to become heart beating organ donors).

Preferred Sources: Discharge Summary, Nursing Discharge Notes, Physician Progress Notes, Transfer Notes

VIII-3a If patient died in ICU, life support status at death

Definition Code status is a physician documented indication as to the patient's wishes for further treatment, or lack thereof, should they have a cardiopulmonary arrest.

Instructions

- Full code - no restrictions on therapies or interventions.
- DNR/No CPR - applies where there is NO chest compression, NO intubation and NO electrical cardioversion permitted. ALL 3 therapies must be prohibited to choose this category.
- Limited intervention/Withholding therapy - specific limits are in place which either prevent the initiation of a specific therapy or technology

and/or prevent further increase of a specific therapy or technology. Includes situations in which dialysis, blood product administration, nutritional support, chemical cardioversion & other therapies are not to be initiated. Also includes the situation in which it is permitted to do one or two of the interventions listed in the CPR category but not all 3.

- Withdrawing therapy/Comfort care - applies to situations in which therapy already in place is being withdrawn or removed. Commonly referred as palliative care in the medical community. This may include any OR all of the following: removal from vent support, removal of pressors, stopping of dialysis and/or stopping of other therapeutic measures. Palliative care includes attention to the psychological and spiritual needs of the patient and support for the dying patient and the patient's family. Comfort Measure Only are not equivalent to the following: Do Not Resuscitate (DNR), living will, no code, no heroic measure.
- Maintenance of circulatory support for organ procurement following determination of brain death.

Preferred Sources: Physician Progress Notes, Discharge Summary, Transfer Summary, Physician Orders, Code Status Documentation

VIII-4 Status at Discharge from Hospital, Alive vs. Dead

Definition The mortality status of the patient at discharge from your hospital.

Justification Required for survival statistics

Instructions Select one of the following to indicate if the patient was alive when discharged from your hospital.

- Alive
- Dead. This includes physician documented brain death that is defined as the absence of brain and brain stem activity indicating death of all brain tissue. Diagnosis of brain death may be made by bedside examination and confirmed by electroencephalography (EEG, brain wave study).

Preferred Sources: Discharge Summary, Transfer Summary, Physician Progress Notes.

VIII-4(cont'd) If patient discharged from hospital alive, disposition of patient

Definition The place or setting to which the patient was discharged.

Justification Determining the population for many measures.

Instructions Select one of the following to indicate where the patient went when discharged from your hospital.

- Routine (went home): Discharged to the patient's home, the home of a relative or friend, or a vacation site, whether or not the patient had been receiving home health services or hospice care at home.
- Another Acute Care hospital: If discharged to any acute care unit at an outside hospital including medical/surgical floor, ICU, operating room, recovery room, or procedural area in the outside hospital. This does not include the emergency department, SNF, rehabilitation unit, or hospice unit that may be located within the outside hospital.
- Against medical advice: Leaves the acute care facility against the advice of the physicians. Documented commonly as AMA or AWOL.
- Skilled Nursing Facility/Intermediate care/Residential Care/Hospice:
  - Skilled Nursing / Intermediate Care: Either an independent facility, or a distinct part of a hospital that provides 24-hour skilled nursing care that does not require the level of care provided in a hospital; includes services such as physical, speech and occupational therapy; assistance with personal care activities such as eating, walking, toileting and bathing; coordinated management of patient care; social services; and activities.
  - Hospice: A medical facility such as hospital, SNF, ICF or freestanding hospice that provide palliative care intended for the end of life.
- Other or unknown

Preferred Sources: Discharge Summary, Transfer Summary

ICU OUTCOMES DATA COLLECTION INSTRUMENT

Instructions for data collectors:

For each quarter of the year, please complete the ICU outcomes data collection instrument for the first 100 consecutive discharges from your hospital that had an ICU stay in any of your ICUs. The following data collection rules apply:

- **Observations are limited to eligible ICU patients who have been discharged from the hospital (This includes patients who have died).**
- **Hospitals that do not have 100 hospital discharges with an ICU stay during a quarter must collect information on ALL eligible patients for that quarter**

Patient Eligibility

A.) Is the patient ≥ 18 years of age at the time of admission to the ICU? ❒ YES ❒ NO/Unknown

If NO ⇒ End Abstraction

B.) Is this the patient's first ICU admission during the current hospitalization? ❒ YES ❒ NO/Unknown

If NO ⇒ End Abstraction

C.) Was the patient cared for in the ICU for ≥ 4 hours? ❒ YES ❒ NO/Unknown

If NO ⇒ End Abstraction

D.) Was the patient's primary reason for admission due to Trauma, Burns, or immediately after Coronary Bypass Graft Surgery? ❒ YES ❒ NO/Unknown

If YES ⇒ End Abstraction

E.) Was the patient admitted to "rule out MI", and subsequently determined not to have a myocardial infarction, or another acute process requiring ICU care? ❒ YES ❒ NO/Unknown

If YES ⇒ End Abstraction

Section I. Case/Patient Identification

I-1 a. Abstractor's Certification number: _____

b. Abstractor's Certification number: _____

c. Abstractor's Certification number: _____

I-2 Hospital ID #: _____

I-3 Hospital Medical Record Number (MRN): _____

I-4 Hospital Account Number (aka case number):_____

I-5 SSN: _____-_____-_____

I-6 a. DOB: ___/___/____ b. Age:_____
mm dd yyyy

I-7 SEX: Male ❑ Female ❑

Section II. Hospital Arrival / Index ICU Admission

The index ICU admission is the 1st ICU admission (of ≥ 4 hours) during a hospitalization.

II-1 **HOSPITAL** Arrival (Your Hospital) DATE ___/___/____ (mm dd yyyy) TIME: _ _ : _ _

II-2 **ICU** Admission DATE ___/___/____ (mm dd yyyy) TIME: _ _ : _ _

(Note: See data dictionary if patient admitted to ICU for ≥4 hours AND only for routine pre-operative monitoring prior to an elective surgery)

II-3 Please indicate the type of ICU to which the patient was admitted:

- ❑ a. Coronary Care / CCU
- ❑ b. Cardiothoracic
- ❑ c. Medical
- ❑ d. Combined Medical/Surgical
- ❑ e. Neurosurgical
- ❑ f. Respiratory
- ❑ g. Surgical
- ❑ h. Trauma
- ❑ i. Other / Unknown

Section III. Site Immediately Prior to this ICU Admission

III-1 Please indicate the care site prior to this ICU Admission (Choose One Below, a-g)

- ❑ a. Your Acute-Care Hospital
- ❑ b. Another Acute-Care Hospital
- ❑ c. SNF / Intermediate Care (**Skip to IV-1**)
- ❑ d. Rehabilitation Unit (**Skip to IV-1**)
- ❑ e. Direct Admit – Physician (**Skip to IV-1**)
- ❑ f. Home (**Skip to IV-1**)
- ❑ g. Other _____ (**Skip to IV-1**)

III-1a ***If your choice above is "a" (Your Hospital)*** ⇨ Indicate the department/unit care site prior to ICU admission.(Choose One) Then enter date and time patient admitted to the prior *department/unit* of care.

- ❑ Ward or Floor Unit
- ❑ Emergency Department
- ❑ Cardiac Catheterization Lab
- ❑ Step Down / Transitional Care Unit
- ❑ Operating Room or Surgical Recovery Room
- ❑ Other ICU
- ❑ Unknown

Enter ⇨ DATE:___/___/____ (mm dd yyyy) TIME: _ _ : _ _ entered prior department/unit of care.

III-1b ***If your choice above is "b" (Another Hospital)*** ⇨ Enter date the patient was admitted to the prior *hospital*.

Enter ⇨ DATE:___/___/____ (mm dd yyyy)

Section IV. Patient Characteristics on ICU Admission

	YES	NO	UNKNOWN
IV-1 Was the patient receiving mechanical ventilation at ICU admission or within one hour after arrival to the ICU?	❑	❑	❑
IV-2 Cardiopulmonary resuscitation within 24 hours prior to ICU admission?	❑	❑	❑
IV-3 Did the patient have intracranial mass effect at ICU admission or diagnosed within one hour after arrival to the ICU?	❑	❑	❑
IV-4 Was the patient admitted to the ICU following a percutaneous transluminal coronary angioplasty (PTCA), coronary artery stenting and/or coronary angiography procedure?	❑	❑	❑

	YES	NO	UNKNOWN
IV-5 Did the patient have surgery prior to ICU admission?	❑	❑	❑

IV-5a **If YES to IV-5** ⇒ Was the Surgery: ❑ Scheduled (Scheduled ≥24 hours in advance)
❑ Unscheduled (Scheduled < 24 hours in advance)

IV-5b **If Unscheduled** ⇒ Was the Surgery: ❑ Emergent
❑ Non-Emergent

IV-6 Highest Heart Rate within 1 hour before or after ICU admission _____ BPM

IV-7 Lowest BP (based upon the systolic) within 1 hour before or after ICU admission _____ /

IV-8 Life support status at admission to the ICU**:** (Choose One)

- ❑ Full Code
- ❑ DNR/ No CPR
- ❑ Maintenance of circulatory support for organ procurement
- ❑ Limited Interventions/Withholding Therapy
- ❑ Withdrawing Therapy/ Comfort Care
- ❑ Unknown

Section V. Acute Diagnoses

At ICU admission, please indicate whether any of the following acute diagnoses are present (Select ALL that apply):

Cardiac Arrhythmias / Rhythm Disturbance (do NOT include chronic, stable arrhythmias)
- ❑ Atrial fibrillation / flutter with rapid ventricular response (HR ≥ 100)
- ❑ Other supraventricular: SVT / PSVT / WPW
- ❑ 2nd degree or 3rd degree heart block
- ❑ Ventricular tachycardia / fibrillation
- ❑ Other rhythm disturbance, not chronic / not stable

Cardiac Surgery
- ❑ Patient admitted to ICU after cardiac surgery

Gastrointestinal Bleeding (includes only clinically apparent GI bleeding. Examples include hematemesis, coffee ground emesis, or melena; a drop in hematocrit or perforated ulcer alone is NOT sufficient)
- ❑ Upper GI bleed from esophageal varices / or portal hypertension
- ❑ Upper GI Bleed, other source
- ❑ Lower GI Bleed
- ❑ GI Bleed, unknown source

Sepsis
- ❑ Sepsis present

Renal
- ❑ Acute renal failure OR Acute on chronic renal failure, Prerenal type
- ❑ Acute renal failure OR Acute on chronic renal failure, Non-prerenal type
- ❑ Acute renal failure OR Acute on chronic renal failure, Unknown type

Neurologic

Coma or Deep Stupor: (Does not include coma/deep stupor secondary to physician administered paralytic and/or sedative medications).
- ❑ Coma or deep stupor, traumatic
- ❑ Coma or deep stupor, non-traumatic
- ❑ Coma or deep stupor, due to drug overdose

Cerebrovascular Incident:
- ❑ Arteriovenous malformation *with* subarachnoid hemorrhage or stroke / hemorrhage
- ❑ Cerebrovascular accident / CVA /stroke (embolic and/or thrombotic)
- ❑ Epidural hematoma
- ❑ Subarachnoid hemorrhage / intracranial aneurysm (bleeding)
- ❑ Subdural hematoma
- ❑ Intracranial hemorrhage / hematoma, other

Section VI. Medical History

Does the patient have any of the following medical conditions / treatments that have been diagnosed, symptomatic, or ongoing in the six months prior to admission? (Select all that apply).

Hepatic

- ❑ Confirmed cirrhosis
  - ❑ By Biopsy ❑ Other/Not Known
- ❑ Portal hypertension
- ❑ Jaundice and Ascites
- ❑ Esophageal and/or gastric varices
- ❑ GI bleed attributable to portal hypertension (e.g. variceal bleed)
- ❑ Hepatic encephalopathy

Renal

- ❑ Renal dysfunction w/out dialysis but baseline creatinine >2.0 mg/dL (>176.8umol/L)
- ❑ Chronic dialysis (Hemo or CAPD/Peritoneal)

Oncologic

- ❑ Metastatic disease, solid tumor type (metastasis identified by clinical assessment or biopsy proven)
- ❑ Chronic myelogenous or chronic lymphocytic leukemia AND active treatment
- ❑ Chronic myelogenous or chronic lymphocytic leukemia AND at least one of the following complications secondary to the leukemia: sepsis, anemia, stroke caused by clumping of white blood cells, tumor lysis syndrome, pulmonary edema, or ARDS
- ❑ Acute myelogenous or acute lymphocytic leukemia, multiple myeloma, or other acute hematologic malignancy
- ❑ Lymphoma

Section VII. Mental Status

Using the Glasgow Coma Score (GCS) table below:

VII-1 What was the patient's GCS **at admission** to the ICU? For patients under the effects of paralytic or sedative medications use your best clinical judgment to estimate the GCS **prior** to initiation of sedation. (Please use Scale 1 below if not intubated or Scale 2 below if intubated).

EYE ____ MOTOR ____ VERBAL ____

VII-1a Please indicate if GCS from VII-1 is: ❑ Physician / nurse documented ❑ Abstractor Estimated

VII-2 Was the patient's level of consciousness significantly depressed due to the effects of sedative or paralytic agents at admission to the ICU? Yes ❑ No ❑

GCS Table

Scale 1. GCS score If *NOT* intubated:

Eye opening	***Motor response***	***Verbal Response***
(4) Spontaneous	**(6)** Obeys verbal command	**(5)** Oriented and converses
(3) To verbal command	**(5)** Localizes pain	**(4)** Disoriented and converses
(2) To pain	**(4)** Flexion withdrawal	**(3)** Inappropriate words
(1) No response	**(3)** Flexion-abnormal / decorticate	**(2)** Incomprehensible sounds
	(2) Extension / decerebrate	**(1)** No response
	(1) No response	

Scale 2. GCS Score if intubated or other communication barrier (For example: aphasia, foreign language, etc.):

Eye opening	***Motor response***	***Verbal Response***
(4) Spontaneous	**(6)** Obeys verbal command	**(5)** Clearly oriented and able to communicate or indicate needs
(3) To verbal command	**(5)** Localizes pain	**(3)** Responsive, but orientation is questionable
(2) To pain	**(4)** Flexion withdrawal	**(1)** Completely unresponsive
(1) No response	**(3)** Flexion-abnormal / decorticate	
	(2) Extension / decerebrate	
	(1) No response	

Section VIII. Discharge

VIII-1 **ICU** Discharge DATE: ___/___/____ TIME: _ _ : _ _
mm dd yyyy

VIII-2 **HOSPITAL** Discharge DATE: ___/___/____ TIME: _ _ : _ _
mm dd yyyy

VIII-3 Status of patient at **ICU** discharge:

- ❑ Stable
- ❑ Dead
- ❑ Heart still beating but under consideration for organ donation
- ❑ Discharged for comfort care with no expectation of recovery

If the patient died in the ICU ⇨code status at death (Choose one):

- ❑ Full Code
- ❑ DNR/ No CPR
- ❑ Withdrawing Therapy/ Comfort Care
- ❑ Limited Interventions/Withholding Therapy
- ❑ Maintenance of circulatory support for organ procurement
- ❑ Unknown

VIII-4 Status at **HOSPITAL** discharge: Alive ❑ Dead ❑

If alive at HOSPITAL discharge ⇨what was the disposition of the patient?

- ❑ Home
- ❑ Against medical advice
- ❑ Another Acute Care Hospital
- ❑ SNF/ Intermediate Care / Resident Care Facility
- ❑ Hospice
- ❑ Other
- ❑ Unknown

Mortality Probability Model III and Simplified Acute Physiology Score II

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Mortality Probability Model III and Simplified Acute Physiology Score II

Assessing Their Value in Predicting Length of Stay and Comparison to APACHE IV

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Background: **To develop and compare ICU length-of-stay (LOS) risk-adjustment models using three commonly used mortality or LOS prediction models.**

Methods: **Between 2001 and 2004, we performed a retrospective, observational study of 11,295 ICU patients from 35 hospitals in the California Intensive Care Outcomes Project. We compared the accuracy of the following three LOS models: a recalibrated acute physiology and chronic health evaluation (APACHE) IV-LOS model; and models developed using risk factors in the mortality probability model III at zero hours (MPM_0) and the simplified acute physiology score (SAPS) II mortality prediction model. We evaluated models by calculating the following: (1) grouped coefficients of determination; (2) differences between observed and predicted LOS across subgroups; and (3) intraclass correlations of observed/expected LOS ratios between models.**

Results: **The grouped coefficients of determination were APACHE IV with coefficients recalibrated to the LOS values of the study cohort (APACHE IVrecal) [$R^2 = 0.422$], mortality probability model III at zero hours (MPM_0 III) [$R^2 = 0.279$], and simplified acute physiology score (SAPS II) [$R^2 = 0.008$]. For each decile of predicted ICU LOS, the mean predicted LOS vs the observed LOS was significantly different ($p \leq 0.05$) for three, two, and six deciles using APACHE IVrecal, MPM_0 III, and SAPS II, respectively. Plots of the predicted vs the observed LOS ratios of the hospitals revealed a threefold variation in LOS among hospitals with high model correlations.**

Conclusions: **APACHE IV and MPM_0 III were more accurate than SAPS II for the prediction of ICU LOS. APACHE IV is the most accurate and best calibrated model. Although it is less accurate, MPM_0 III may be a reasonable option if the data collection burden or the treatment effect bias is a consideration.** ***(CHEST 2009; 136:89–101)***

Abbreviations: APACHE = acute physiology and chronic health evaluation; APACHE IVorig = acute physiology and chronic health evaluation using coefficients described by the original publication of the acute physiology and chronic health evaluation IV length-of-stay model; APACHE IVrecal = acute physiology and chronic health evaluation IV with coefficients recalibrated to the length-of-stay values of the study cohort; CABG = coronary artery bypass graft; CALICO = California Intensive Care Outcomes; CI = confidence interval; DNR = do not resuscitate; LOS = length of stay; MPM_0 III = mortality probability model III at zero hours; SAPS = simplified acute physiology score; SLOSR = standardized length of stay ratio

The ICU provides advanced and resource-intensive treatment for the sickest hospitalized patients. Care in the ICU accounts for approximately 13% of hospital costs and 4.2% of national health expenditures.[1] These costs are largely explained by the length of stay (LOS) in the ICU.[2,3] There is significant variation in ICU LOS among hospitals that persists even after adjusting for patient risk factors.[4–6] This possibly reflects variations in ICU organization, safety, quality, or other hospital or community factors such as the availability of non-ICU beds.[7–10]

An important objective is to identify ICUs requiring longer or shorter LOSs after accounting for differences in patient characteristics. Comparing risk-adjusted ICU LOSs among ICUs may prove complementary to risk-adjusted mortality and process measures in assessing ICU performance.[11] The Joint Commission[12] and others[13] have expressed interest in public reporting of risk-adjusted ICU LOS.

The acute physiology and chronic health evaluation (APACHE [a registered trademark of Cerner Corporation; Kansas City, MO])[14,15] system is the only validated ICU risk-adjustment model that provides performance information about two separate outcomes of care (mortality and ICU LOS). The APACHE IV model is the most recent version. Two other validated ICU mortality prediction models, the mortality probability model III at zero hours (MPM_0 III) and the simplified acute physiology score (SAPS) II, use alternative risk-adjustment methods to assess mortality, although they have not been used for LOS prediction.[16,17] MPM_0 III and SAPS are important to consider for LOS risk adjustment because, as with APACHE, using the data collected for mortality prediction may provide an efficient means of assessing LOS. In addition, both models are used for the purposes of risk adjustment.[18,19] In contrast to APACHE, they have fewer risk factors and impose less of a data collection burden.[20]

We used data from > 11,000 patients in the California Intensive Care Outcomes (CALICO) project to develop and compare the performance of APACHE IV, MPM_0 III, and SAPS II models in LOS prediction. In addition, we explored additional patient and hospital factors that may influence ICU LOS or hospital rankings.

Materials and Methods

Hospital Selection

All California hospitals were sent a recruiting packet. A network of volunteer hospitals was established through mailings and regional presentations.

Patient Selection

Data were collected between 2001 and 2004. Inclusion criteria were age ≥ 18 years and ICU stay ≥ 4 h. We excluded patients with conditions that were not examined across each risk-adjustment model, including burns, trauma, and coronary artery bypass graft (CABG) patients. In addition, we excluded patients who had been readmitted to the ICU, consistent with prior studies, and only abstracted data from the index ICU admission. We utilized a proportional sampling method where the goal sample size depended on the hospitals' annual number of ICU admissions.[20]

Risk Models and Variables

We used the MPM_0 III and SAPS II variables specified in their mortality model publications to create a LOS predictive model.[16,17] For the APACHE IV model, we used predictor variables detailed in the ICU LOS model publication.[15] Trained nurses from participating hospitals abstracted data for all models. ICU LOS, defined in hours and minutes, was the time at discharge from the ICU (either death or physical departure from the unit) minus the time of admission (first recorded vital sign on the ICU flow sheet). The LOS was calculated in days to the second significant digit and truncated at 30 days to minimize the impact of outliers, as previous investigators have done.[14,15] MPM_0 III

From the Philip R. Lee Institute for Health Policy Studies (Drs. Vasilevskis, Kuzniewicz, Lane, and Dudley, Ms. Dean, Mr. Clay, and Ms. Rennie), the Divisions of General Internal Medicine (Dr. Vasilevskis), Hospital Medicine (Dr. Vasilevskis), Neonatology (Dr. Kuzniewicz), and Pulmonary and Critical Care Medicine (Dr. Dudley), and the Departments of Anesthesiology and Perioperative Medicine (Drs. Cason and Lane), and Epidemiology and Biostatistics (Dr. Vittinghoff), University of California at San Francisco, San Francisco, CA; Veterans Affairs Medical Center (Dr. Cason), San Francisco, CA; the Department of Medicine (General Internal Medicine and Public Health) [Dr. Vasilevskis], Vanderbilt University, Nashville, TN; and Geriatric Research Education and Clinical Care (Dr. Vasilevskis), and the Clinical Research Training Center of Excellence (Dr. Vasilevskis), Department of Veterans Affairs, Tennessee Valley Healthcare System, Nashville, TN.

Dr. Vasilevskis had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Responsibility for areas of the study were as follows: study concept and design: Drs. Vasilevskis, Kuzniewicz, and Dudley; acquisition of data: Drs. Kuzniewicz, Cason, Lane, and Dudley, and Ms. Dean; analysis and interpretation of data: Drs. Vasilevskis, Kuzniewicz, Cason, Lane, Vittinghoff, and Dudley, Ms. Dean, Mr. Clay, and Ms. Rennie; drafting of the manuscript: Drs. Vasilevskis and Dudley; critical revision of the manuscript for important intellectual content: Drs. Vasilevskis, Kuzniewicz, Cason, Lane, Vittinghoff, and Dudley, Ms. Dean, Mr. Clay, and Ms. Rennie; statistical analysis: Drs. Vasilevskis and Vittinghoff, and Mr. Clay; obtained funding: Dr. Dudley; administrative, technical, or material support: Drs. Cason and Lane, Ms. Dean, and Ms. Rennie; and study supervision: Ms. Dean and Dr. Dudley.

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required collection of variables within 1 h of admission to the ICU. The other models used the most abnormal physiologic values in the first day after ICU admission. A list of diagnoses organized by system and condition was used to code the reason for ICU admission.[21] Data collection methods and interrater reliability have been previously described.[20]

Statistical Analysis

We compared CALICO hospital characteristics with all California hospitals that had > 50 hospital beds using the 2004 American Hospital Association survey.[22] Next, we divided data into development (60%) and validation (40%) samples, and used the χ^2 test, Student *t* test, and Mann-Whitney test, where appropriate, to compare characteristics of the samples.

Due to the hierarchical nature of the data (patients clustered within hospitals), we then used mixed-effects, multilevel modeling to generate ICU LOS prediction models for APACHE IV, MPM_0 III, and SAPS II using all variables in the original models. Due to known calibration limitations arising from using estimates of predictive performance on populations other than the one on which a risk model was developed,[23,24] we also reestimated the APACHE IV coefficients on the CALICO data set. This was necessary given the different time period, as well as reports of regional variations in health-care utilization patterns,[25,26] demographic mix,[27,28] and quality of care.[29,30] Our recalibration procedure maintained the original variable weights in the APACHE acute physiology score, as well as the spline knot values. The final models are APACHE IV models using coefficients described by the original publication of the APACHE IV LOS model (APACHE IVorig), APACHE IV with coefficients recalibrated to LOS values of the study cohort (APACHE IVrecal), MPM_0 III LOS model, and SAPS II LOS model.

Multiple methods were used to assess model performance in the validation sample. First, we used the paired Student *t* test to compare mean observed ICU LOS to mean predicted ICU LOS for the entire validation population and for specific subgroups (age groups, medical vs surgical patients, and patients grouped by primary clinical system deranged). Second, we divided the sample into deciles of predicted LOS and used the paired Student *t* test and calibration curves to compare mean predicted LOS to observed LOS for each model. Third, to measure the variance in LOS explained by the models, we calculated coefficients of determination (R^2) equal to the square of the correlation coefficient between the individual predicted LOS and the observed LOS. To assess the proportion of variation across hospitals explained by the models, we performed bivariate regressions of the mean observed LOS against the mean predicted LOS (grouped R^2) for hospitals with > 100 admissions, which was consistent with the intent of the developers of the original APACHE LOS model.[15]

Finally, we compared the assessments by the three models of the performance of the ICU of each hospital. The hospital LOS predictions were standardized by calculating a standardized LOS ratio (SLOSR) that was equal to the mean observed LOS divided by the mean predicted LOS for each hospital. Confidence intervals (CIs) were calculated by the Fieller method.[31] SLOSRs were limited to hospitals with > 100 admissions, which was consistent with prior studies.[15,32] We then assessed intraclass correlations between SLOSRs produced by the models.

Additional Risk Factors and Sensitivity Analyses

Due to the potential relationship of demographic and hospital factors with LOS, we developed additional models using data from the 2004 American Hospital Association survey and the California Office of Statewide Health Planning and Development. We adjusted for "do not resuscitate" (DNR) orders at hospital admission, payor status (Medicare, Medicaid, private, other), and hospital bed size.[33,34] We also used Spearman rank correlations to assess the relationship between demographic patient mix (*eg*, percentage of Medicaid patients) and hospital SLOSR performance assessed by the APACHE IVrecal.

Next, to determine whether hospital SLOSR was sensitive to hospital admission thresholds or the availability of step-down units,[35,36] we developed models after excluding patients with very short (< 24 h) LOSs. In addition, to assess the impact of case mix on performance, we assessed the Spearman correlation between the hospital mean severity of illness and the SLOSR.

Finally, we tested an additional SAPS II model treating each variable as an independent predictor, rather than a summed score, to evaluate for differences in model accuracy. The institutional review boards of the University of California, San Francisco, and the state of California approved the study. All analyses were performed using a statistical software package (STATA, version 9.2; Stata Corp; College Station, TX).

Results

Hospital Characteristics

The 35 participating hospitals included 57% not-for-profit institutions, 29% teaching hospitals, 9% hospitals with < 100 beds, 51% with 100 to 300 beds, and 41% with > 300 beds. Additional information on the CALICO hospitals has been previously published.[20]

Patient Characteristics

A total of 11,366 patients met our inclusion criteria. Of those, 71 patients (0.6%) had missing or indeterminate ICU LOS data, leaving a final data set of 11,295 patients. The overall mean and median LOSs were 4.0 and 2.0 days, respectively. The characteristics between the estimation and validation data sets were statistically similar across all characteristics (Table 1).

Predictive Performance of Four Models

The development sample (n = 6,684) was used to estimate coefficients for each model. Coefficients for MPM_0 III LOS and SAPS II LOS models are given in Table 2. Original coefficients for APACHE IV LOS are publicly available,[12] and reestimated coefficients are given in the Appendix.

Model performance was assessed in the 40% validation sample (n = 4,611). The difference between the mean observed LOS and the predicted ICU LOS for the validation sample was 4.6 h for APACHE IVorig ($p = 0.006$), 1.7 h for APACHE IVrecal ($p = 0.32$), 0.2 h for MPM_0 III LOS ($p = 0.90$), and 0.4 h for SAPS II LOS ($p = 0.82$). Observed LOS vs predicted LOS for strata of age,

Table 1—*Demographic and Clinical Characteristics*

Characteristics	Total Sample (n = 11,295)	Estimation Sample (n = 6,684)	Validation Sample (n = 4,611)	p Value*
Age,† yr	62.2 (17.4)	62.2 (17.6)	62.2 (17.3)	0.94
Age categories‡				0.33
18–44 yr	1,919 (17.0)	1,150 (17.2)	769 (16.7)	
45–64 yr	3,852 (34.1)	2,244 (33.6)	1,608 (34.9)	
65–84 yr	4,578 (40.5)	2,711 (40.6)	1,867 (40.5)	
> 85 yr	946 (8.4)	579 (8.7)	367 (8.0)	
Race‡				0.17
White	6,510 (57.6)	3,787 (56.7)	2,723 (59.1)	
Black	669 (5.9)	409 (6.1)	260 (5.6)	
Hispanic	1,960 (17.4)	1,193 (17.9)	767 (16.6)	
Asian/Pacific Islander	630 (5.6)	379 (5.7)	251 (5.4)	
Native American/other	319 (2.8)	184 (2.8)	135 (2.9)	
Unknown	1,207 (10.7)	732 (11.0)	475 (10.3)	
Expected payor‡				0.27
Medicare	5,021 (44.5)	2,989 (44.7)	2,032 (44.1)	
Medicaid	1,605 (14.2)	962 (14.4)	643 (13.9)	
Private coverage	2,597 (23.0)	1,490 (22.3)	1,107 (24.0)	
Other (*eg*, self-pay, workers' compensation, other government)	865 (7.7)	511 (7.7)	354 (7.7)	
Unknown	1,207 (10.7)	732 (11.0)	475 (10.3)	
DNR patients at admission‡	541 (4.8)	313 (4.7)	228 (4.9)	0.52
Operative status‡				0.65
Nonoperative	8,789 (77.8)	5,181 (77.5)	3,608 (78.3)	
Elective surgery	2,016 (17.9)	1,208 (18.1)	808 (17.5)	
Emergency surgery	490 (4.3)	295 (4.4)	195 (4.2)	
Severity of illness†				
APACHE score	44.9 (27.6)	44.7 (27.4)	45.2 (28.0)	0.31
SAPS II score	33.2 (17.6)	33.1 (17.5)	33.4 (17.7)	0.41
Location prior to ICU admission‡				0.51
Emergency department	5,548 (49.1)	3,270 (48.9)	2,278 (49.4)	
Operating room/recovery room	2,506 (22.2)	1,503 (22.5)	1,003 (21.8)	
Floor	2,426 (21.5)	1,421 (21.3)	1,005 (21.8)	
Transfer from another hospital	440 (3.9)	255 (3.8)	185 (4.0)	
Other	375 (3.3)	235 (3.5)	140 (3.0)	
Primary reason for admission: system‡				0.49
Cardiac	4,699 (41.6)	2,759 (41.3)	1,940 (42.1)	
Pulmonary	2,181 (19.3)	1,286 (19.2)	895 (19.4)	
GI	1,480 (13.1)	900 (13.5)	580 (12.6)	
Neurologic	1,582 (14.0)	923 (13.8)	659 (14.3)	
GU	269 (2.4)	172 (2.6)	97 (2.1)	
Overdose/poisoning	379 (3.4)	216 (3.2)	163 (3.5)	
Metabolic	392 (3.5)	232 (3.5)	160 (3.5)	
Hematologic/oncologic	115 (1.0)	71 (1.1)	44 (1.0)	
Other	198 (1.8)	125 (1.9)	73 (1.6)	
LOS				
Prior LOS,§ d	0.3 (0.1–0.8)	0.3 (0.1–0.8)	0.3 (0.1–0.8)	0.98
ICU LOS,† d	4.0 (6.4)	4.0 (6.7)	4.0 (6.2)	0.93
ICU LOS,§ d	2.0 (1.0–4.1)	2.0 (1.0–4.2)	1.9 (1.0–4.1)	0.24
ICU mortality‡	1,279 (11.4)	752 (11.3)	527 (11.4)	0.77
In-hospital mortality‡	1,766 (15.6)	1,036 (15.5)	730 (15.8)	0.63

GU = genitourinary.

*The p values are based on χ^2 test of statistical independence for categorical data, Student *t* test for parametric data, or Mann-Whitney test for nonparametric data. Totals may not add to 100% due to rounding.

†Values are given as the mean (SD).

‡Values are given as the No. (%).

§Values are given as the median (interquartile range).

medical vs surgical admission status, and the primary system affected leading to ICU admission are displayed in Table 3. APACHE IVorig, APACHE IVrecal, and MPM_0 III LOS each had a single age stratum with significant differences between observed and predicted LOS. SAPS II LOS systematically underpredicted LOS for younger patients and overpredicted LOS for older patients. APACHE

Table 2—*Coefficients for MPM_0 III LOS and SAPS II LOS Models*

Variables	Coefficient for Estimation Sample (n = 6,684)	95% CI
MPM_0 III LOS model		
Heart rate ≥ 150 beats/min	1.6517	0.9290 to 2.3744
SBP ≤ 90 mm Hg	0.1442	−1.0821 to 1.3704
Chronic kidney disease	−0.5952	−1.1567 to −0.0337
Cirrhosis	1.3865	−1.4989 to 4.2718
Coma/deep stupor	−1.4622	−3.4426 to 0.5182
Metastatic neoplasm	3.4601	1.1031 to 5.8171
Acute renal failure	0.6548	−0.1365 to 1.4461
Cardiac dysrhythmia	−0.9552	−3.0329 to 1.1225
Cerebrovascular incident	1.1122	0.5227 to 1.7016
GI bleed	−0.7975	−1.3560 to −0.2390
Intracranial mass effect	1.8107	−0.0294 to 3.6508
CPR before ICU admission	1.9279	−0.5657 to 4.4215
Mechanical ventilation	2.4888	2.1530 to 2.8246
Unscheduled surgical admission or medical admission	1.3964	1.0410 to 1.7518
Age (per 10 yr)	0.1369	0.0562 to 0.2176
Full code on ICU admission	0.8537	0.2926 to 1.4147
Zero risk factors (no factors other than age)	−0.6006	−0.9936 to −0.2076
Interaction terms		
Age coma/deep stupor	0.1247	−0.1714 to 0.4208
Age SBP ≤ 90 mm Hg	0.0165	−0.1667 to 0.1997
Age cirrhosis	−0.0546	−0.5703 to 0.4610
Age metastatic neoplasm	−0.4949	−0.8649 to −0.1249
Age cardiac dysrhythmia	−0.0051	−0.2941 to 0.2838
Age intracranial mass effect	−0.3209	−0.6210 to −0.0208
Age CPR prior to admission	−0.2442	−0.6078 to 0.1193
Intercept	0.5566	−0.3409 to 1.4541
SAPS II LOS model		
SAPS score	0.0178	0.0019 to 0.0337
Log (SAPS score)	1.6057	1.1150 to 2.0965
Intercept	−2.2334	−3.4928 to −0.9741

CPR = cardiopulmonary resuscitation; SBP = systolic BP.

IVrecal and MPM_0 III-LOS accurately predicted ICU LOS for medical and elective surgical patients. For more specific diagnostic categories, including emergency surgery, APACHE IVrecal was the most accurate.

For each decile of predicted ICU LOS, the difference between mean observed and predicted LOS differed significantly ($p \leq 0.05$) for 6, 3, 2, and 6 of the 10 deciles, respectively, using APACHE IVorig, APACHE IVrecal, MPM_0 III LOS, and SAPS II LOS (Table 4). This is graphically represented in Figure 1 as calibration curves. The calibration curve of APACHE IVorig demonstrates poor fit at the lowest deciles. APACHE IVrecal demonstrates excellent fit, with the poorest calibration in the lowest decile. MPM_0 III LOS demonstrates an excellent fit as well. SAPS II LOS appears to have a poor fit across multiple deciles.

The coefficients of determination for patient-level ICU LOS predictions were as follows: APACHE IVorig, $R^2 = 0.182$; APACHE IVrecal, $R^2 = 0.202$; MPM_0 III LOS, $R^2 = 0.098$; and SAPS II LOS, $R^2 = 0.049$. Grouped R^2 analysis for the 29 hospitals with > 100 admissions were as follows: APACHE IVorig, $R^2 = 0.439$; APACHE IVrecal, $R^2 = 0.422$; MPM_0 III LOS, $R^2 = 0.279$; and SAPS II LOS, $R^2 = 0.008$. This indicates that 42% and 28%, respectively, of the ICU LOS variations are accounted for by APACHE IVrecal and MPM_0 III-LOS.

Finally, Figure 2 displays a comparison of the predictions of the models for hospital-level SLOSRs, excluding the original APACHE model. Regardless of the model used, there was significant variation in SLOSRs among 29 hospitals with > 100 admissions. There were similar ranges among the SLOSRs of the hospitals for each model as follows: APACHE IVrecal, 0.47 to 1.60; MPM_0 III LOS, 0.40 to 1.68; and SAPS II LOS, 0.38 to 1.69. The intraclass correlations of the SLOSRs between each pair of models were high: APACHE IVrecal and MPM_0 III-LOS, $r = 0.89$ (95% CI, 0.74 to 0.96); APACHE IVrecal and SAPS II-LOS, $r = 0.85$ (95% CI, 0.70 to 0.93); and MPM_0 III-LOS and SAPS II-LOS, $r = 0.96$ (95% CI, 0.92 to 0.98).

Additional Risk Factors and Sensitivity Analyses

The addition of DNR status and Medicaid payment (when compared to private insurance) to APACHE IV models independently predicted shorter LOS (−1.10 days; 95% CI, −0.57 to −1.65) and longer LOS (0.74 days; 95% CI, 0.38 to 1.09), respectively. The number of hospital beds had no effect. Each of these factors did not significantly improve the accuracy, calibration, or agreement of hospital SLOSRs between each model. In addition, there was no statistically significant correlation between percentages of DNR patients ($r = 0.18$; $p = 0.36$) or Medicaid patients ($r = 0.35$; $p = 0.06$) of the hospital and the SLOSR. Likewise, there was no statistically significant correlation between bed size ($r = -0.25$; $p = 0.22$) and SLOSR.

Models developed on the population excluding patients with the short ICU LOS (< 24 h) maintained excellent calibration for APACHE IVrecal and improved calibration for MPM_0 III LOS. The range of SLOSRs for each model when excluding patients with LOS < 24 h (SLOSR range: APACHE

Table 3—*Difference Between Observed and Predicted LOS for Age and Primary Medical/Surgical System Categories on Validation Sample*

Variables	Patients, No.	APACHE IVorig Model		APACHE IVrecal Model		MPM_0 III LOS Model		SAPS II LOS Model	
		Difference of Observed Minus Predicted, d	p Value*	Difference of Observed Minus Predicted, d	p Value*	Difference of Observed Minus Predicted, d	p Value*	Difference of Observed Minus Predicted, d	p Value*
Age									
18–30 yr	224	0.5	0.08	0.2	0.4	0.0	0.93	0.8	0.006
31–45 yr	602	0.1	0.46	0.0	1.0	−0.1	0.61	0.4	0.03
46–60 yr	1,209	0.4	0.003	0.1	0.45	0.3	0.04	0.5	0.002
61–70 yr	864	0.2	0.14	0.0	0.89	0.1	0.39	0.1	0.74
71–80 yr	1,012	−0.1	0.31	−0.3	0.02	−0.2	0.11	−0.6	< 0.001
≥ 81 yr	700	0.2	0.37	−0.2	0.18	−0.2	0.18	−0.8	< 0.001
Medical vs surgical status									
Elective surgery	808	0.3	0.04	−0.1	0.64	0.0	0.8	−0.1	0.27
Emergency surgery	195	0.3	0.45	0.2	0.67	0.8	0.05	1.4	0.002
Medical	3608	0.2	0.04	−0.1	0.29	0.0	0.75	−0.1	0.45
Medical/surgical system									
Cardiac medical	1,670	0.0	0.88	−0.2	0.02	−0.4	< 0.001	−0.8	< 0.001
Cardiac surgical	270	0.5	0.03	0.2	0.46	−0.2	0.48	−0.4	0.1
Pulmonary medical	759	0.7	0.006	0.3	0.28	1.5	< 0.001	1.9	< 0.001
Pulmonary surgical	136	0.7	0.10	−0.2	0.61	0.5	0.21	0.4	0.38
GI medical	297	−0.1	0.53	−0.4	0.12	−0.4	0.1	−0.7	0.002
GI surgical	283	0.2	0.60	0.0	0.88	0.7	0.03	0.8	0.009
Neurologic medical	441	−0.1	0.56	−0.3	0.22	−0.3	0.28	0.3	0.29
Neurologic surgical	218	0.1	0.77	−0.1	0.8	0.0	0.91	0.1	0.63
GU medical	63	0.7	0.37	0.5	0.55	0.4	0.66	0.0	0.97
GU surgical	34	−0.1	0.77	−0.1	0.83	−0.4	0.26	−0.7	0.04
Overdose/poisoning	163	0.21	0.38	0.2	0.5	−1.4	< 0.001	−0.8	0.001
Metabolic	160	0.5	0.03	0.2	0.31	−0.7	0.003	−1.0	< 0.001
Hematology/oncology	44	−0.8	0.03	−1.4	< 0.001	−1.3	0.003	−1.6	< 0.001
Other	73	1.1	0.12	1.0	0.13	0.3	0.7	0.6	0.37

*Based on paired Student *t* tests. See Table 1 for abbreviation not used in the text.

Table 4—*Differences Between Observed and Predicted LOS Across Decile of Predicted LOS for Each Model in Validation Data Set*

Decile of Predicted ICU LOS,* %	APACHE IVorig Model					APACHE IVrecal Model					MPM III_0 LOS Model					SAPS II LOS Model				
	Patients, No.	Mean Observed ICU LOS, d	Mean Predicted ICU LOS, d	Difference of Observed-Predicted LOS, d	p Value†	Patients, No.	Mean Observed ICU LOS, d	Mean Predicted ICU LOS, d	Difference of Observed-Predicted LOS, d	p Value†	Patients, No.	Mean Observed ICU LOS, d	Mean Predicted ICU LOS, d	Difference of Observed-Predicted LOS, d	p Value†	Patients, No.	Mean Observed ICU LOS, d	Mean Predicted ICU LOS, d	Difference of Observed-Predicted LOS, d	p Value†
0–10	462	1.5	0.6	0.9	< 0.001	462	1.5	0.9	0.7	< 0.001	462	2.4	2.0	0.3	0.05	564	2.0	1.8	0.2	0.08
11–20	461	1.8	1.2	0.6	< 0.001	461	1.8	1.6	0.1	0.19	462	2.4	2.5	−0.1	0.45	381	2.4	2.8	−0.4	0.03
21–30	461	2.1	1.6	0.5	< 0.001	461	2.1	2.0	0.1	0.33	461	2.7	2.7	0.0	0.84	525	2.5	3.1	−0.6	< 0.001
31–40	461	2.4	2.1	0.4	0.003	461	2.5	2.4	0.1	0.48	464	3.1	3.0	0.1	0.53	426	2.7	3.4	−0.7	< 0.001
41–50	461	2.9	2.7	−0.2	0.23	461	2.8	3.0	−0.2	0.16	457	3.2	3.1	0.1	0.67	470	3.6	3.7	−0.1	0.77
51–60	461	3.2	3.5	−0.3	0.11	461	3.2	3.6	−0.4	0.03	461	2.8	3.3	−0.5	< 0.001	446	3.6	4.0	−0.4	0.10
61–70	461	3.9	4.3	−0.4	0.05	461	4.2	4.5	−0.3	0.17	461	3.8	3.9	−0.1	0.66	454	4.7	4.3	0.4	0.11
71–80	461	4.9	5.3	−0.4	0.16	461	4.9	5.4	−0.5	0.04	462	4.4	4.8	−0.4	0.15	457	5.4	4.6	0.8	< 0.01
81–90	461	6.1	6.5	−0.4	0.18	461	6.6	6.6	0.0	0.92	464	6.1	5.8	0.3	0.33	456	6.8	5.1	1.7	< 0.001
91–100	461	9.1	8.3	0.8	0.05	461	8.4	8.7	−0.3	0.48	457	7.1	6.7	0.4	0.29	432	4.6	5.9	−1.4	< 0.001

*Population sorted by increasing predicted risk and then split into deciles.
†Based on paired Student *t* test.

IVrecal, 0.58 to 1.49; MPM_0 III LOS, 0.61 to 1.46; and SAPS II LOS, 0.55 to 1.53) was smaller than the range of SLOSRs produced when using all patients in the sample, with comparable agreement. There was no correlation between the mean severity of illness of the hospitals ($r = -0.05$; $p = 0.80$) and the SLOSR. The mean SLOSRs of the five hospitals with the lowest and highest mean severity of illness were 1.0 (SD, 0.2) and 1.0 (SD, 0.3), respectively.

Finally, a model based on the SAPS II LOS independent variables revealed no meaningful differences in accuracy ($R^2 = 0.061$) and calibration between that and the primary SAPS II model used in the analyses just cited. No further data from that model are presented.

Discussion

Our study is the first description of the use of MPM_0 III LOS and SAPS II LOS variables for the additional purpose of predicting risk-adjusted ICU LOS. In addition, our study is the first independent validation of the APACHE IV LOS model. We have shown MPM_0 III LOS, an alternative risk-adjustment model originally developed for mortality prediction, can also be used for predicting LOS in a broad medical and surgical population. However, SAPS II LOS did not appear well suited for LOS prediction. The MPM_0 III LOS model explains the lower variation in hospital-level LOSs but requires substantially fewer resources to implement than the APACHE IV LOS model. Individual hospitals received similar rankings with these two models.

Regardless of the model, we observed sizable variations in risk-adjusted LOS performance among hospitals that could not be accounted for by patient risk factors. The apparent variation in ICU LOS after accounting for differences in patient severity of illness supports the need to assess risk-adjusted ICU LOS as one aspect of performance.

The primary objective of our study was to assess the utility of two established mortality prediction models in predicting an alternative outcome, ICU LOS, and to compare these models to the APACHE IVorig and APACHE IVrecal models. With regard to model accuracy, APACHE IVrecal has the best predictive accuracy across clinical categories, excellent calibration, and the highest grouped R^2. The APACHE IVrecal model proved more accurate when compared to the APACHE IVorig model. There are many potential reasons for this, as follows: (1) the CALICO cohort had a different patient mix, including more nonsurgical patients and higher

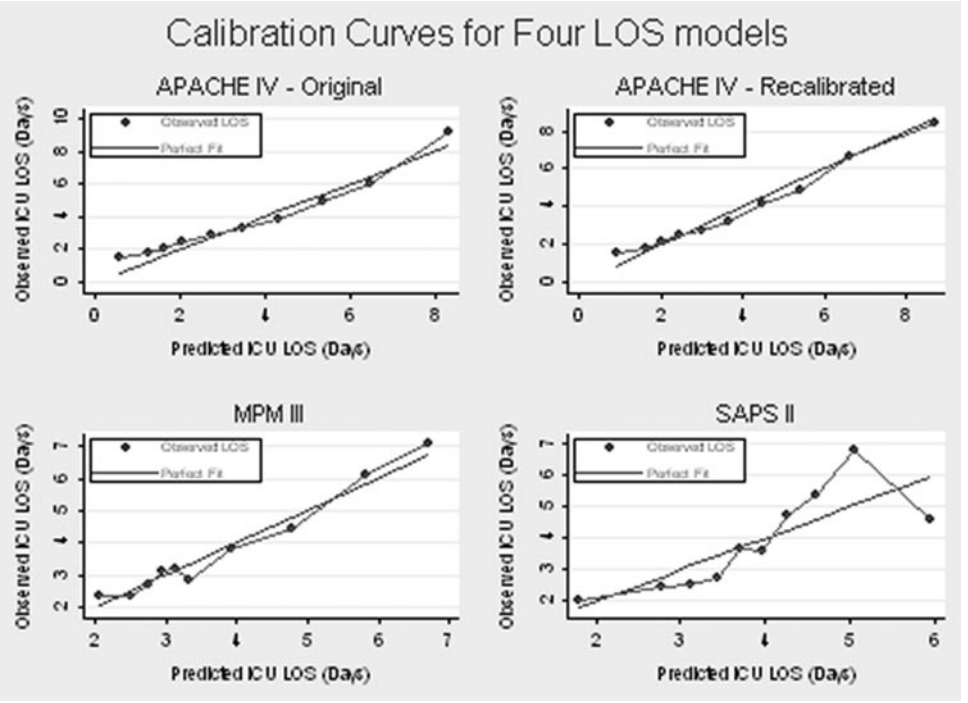

FIGURE 1. Calibration curves comparing mean observed and mean predicted ICU LOS for four ICU LOS models.

mean APACHE score; (2) when compared to APACHE IVorig, the coefficients for individual risk factors differed across many domains, including, but not limited to, acute and chronic diagnoses; (3) patterns in health-care utilization may differ in the CALICO cohort; and (4) in contrast to CALICO hospitals, the APACHE IV cohort hospitals were users of the APACHE system,[15] which could be a marker of increased attention toward quality, efficiency, and information technology.

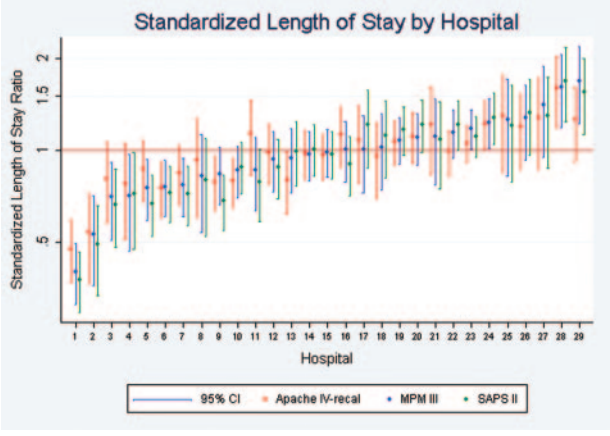

FIGURE 2. Plot of LOS prediction model-specific SLOSRs for each hospital with at least 100 admissions.

The superior predictive accuracy of APACHE IVrecal compared to the other models may be explained by having more variables. Including the ICU admitting diagnosis may be particularly influential because prior research[15] has shown that they account for up to 17% of the explanatory power of the original APACHE IV model. In addition, the use of linear splines to model nonlinearities in predictor response (*eg*, acute physiology score) address the reality that patients with both the lowest and highest acute physiology scores will generally have shorter average LOSs.[15] Alternatively, it may be that part of the additional predictive power comes from including variables that reflect pre-ICU care, such as pre-ICU LOS and admission source, or response to treatment (because the worst physiology values for the first 24 h are included). Further research is needed to define the source of the additional predictive power and to assess whether including these variables is actually desirable. For instance, if the model predicts LOS better because it "risk adjusts" for undertreatment, that may not be desirable.

The poor accuracy of SAPS II LOS suggests that this model is inadequate for predicting LOS. The limited value of the SAPS II LOS model might be improved by reweighting the individual variables that make up the SAPS II LOS score or modeling

their relationships to LOS as nonlinear. Treating the individual variables as independent rather than summarized did not provide significant additional benefit.

With > 100 fewer model coefficients than APACHE IVrecal and without modeling nonlinear relationships, the MPM_0 III LOS model nonetheless displayed fair accuracy and excellent calibration. Despite a low R^2 for predicting an individual patient's LOS, MPM_0 III LOS was effective in predicting LOS across hospital, demographic, and broad clinical groups. The inability of the MPM_0 III LOS model to predict LOS especially well for derangements of an individual physiologic system reflects the absence in the MPM_0 III model of a variable indicating the system involved. This suggests that MPM_0 III LOS may be poorly suited for assessing the performance of individual specialty ICUs. MPM_0 III LOS may also be poorly suited for assessing ICUs that care for a large proportion of emergency surgery patients (*eg*, trauma ICU). Despite being statistically significant, differences between predicted LOS and actual LOS did not always appear to be clinically significant (*eg*, for the medical cardiac system, a difference of < 12 h). Therefore, if predictions for clinical subgroups are an important goal, the MPM_0 III LOS model may be considered, albeit with caution.

MPM_0 III LOS and APACHE IVrecal were also similar in their appraisals of hospital performance. Performance assessments from the two models were highly correlated ($r = 0.89$) and were not significantly affected by additional patient and hospital factors (*eg*, DNR status, payor status, number of hospital beds). Limiting the sample to patients with an ICU stay of at least 24 h maintained high correlation ($r = 0.85$) and improved calibration of the MPM_0 III LOS model. Improvement in calibration may reflect difficulty in predicting LOS for patients with very short ICU stays due to low severity of illness or early mortality. Performance estimates on this reduced sample were more conservative, as evidenced by a narrower range of SLOSRs. Therefore, one would expect fewer performance outliers in the restricted sample.

With respect to model accuracy, the APACHE IV LOS model is a superior tool for LOS risk adjustment. APACHE IV is an excellent tool for hospital mortality risk adjustment and, unlike the MPM_0 III model, has been applied as well to CABG patients. However, there are real-world limitations in data collection, so using MPM_0 III may be a legitimate consideration. First, MPM_0 III is a validated tool for risk-adjusted mortality,[18] and it involves about a third the data collection time of APACHE IV.[20] Few hospitals currently have ICU risk variables available electronically, and the degree to which hospitals face resource and technology barriers may influence the preferences for MPM_0 III LOS vs APACHE IV LOS.[37,38] However, this benefit of the MPM_0 III LOS model may be lessened if hospitals are not currently using a risk-adjustment model for CABG patients and are considering the measurement of ICU and CABG outcomes. Second, because model performance deteriorates over time or when applied to populations that differ from the one used for model development, another factor to consider is the ability to reestimate the model to the study population. With substantially fewer coefficients, reestimation of the MPM_0 III LOS requires a smaller database and, hence, can be performed more often or when the size of the database does not allow for the recalibration of APACHE. This problem with APACHE would be lessened if the Joint Commission was to adopt a national ICU performance set, therefore creating a large national database with which frequent recalibration would be possible with any model. Finally, the MPM_0 III LOS model only uses risk information from the first hour after a patient's ICU admission, whereas the APACHE IV LOS model requires data be collected throughout the first day of ICU care. Limiting the data collection period may decrease the resources needed to collect data and limits the influence of treatment on the predicted LOS. For example, although hypotension that results from sepsis should be included as a risk factor, hypotension caused by failure to treat appropriately (*eg*, not starting appropriate therapy with antibiotics in sepsis patients) should not. Models that use post-hospital admission data cannot distinguish between these cases, so their better predictive ability may not always serve the purpose of identifying the best performing ICUs.

Our study has important limitations to consider. One is that we used a convenience sample of volunteer hospitals from California. Despite this, the sampling strategy is more likely to affect the estimation of individual model coefficients and is less likely to affect the comparisons between the models. We would recommend a reestimation of the coefficients for all models if applied to a national sample. Second, our hospital sample has a limited number of performance outliers. A larger sample of hospitals is needed to draw more reliable conclusions about the validity of the three models for identifying performance outliers. Third, the recently updated SAPS III model[39] became available after our data collection began, so we did not capture all of its required data elements. Finally, although LOS may be a useful

measure, it is likely affected by hospital discharge policies, bed availability, and community resources. Adding information about these factors might improve the predictive capacity of LOS models, although it would require frequently updated hospital-level information (*eg*, the number of stepdown unit or regular ward beds that are available on each hospital day). In addition, adding these factors to LOS models would mask the extent to which the management of these resources by a hospital contributes to its ICU LOS. Because understanding (and eliminating) the impact of such factors is a goal of clinicians and policymakers who seek to assess ICU LOS, their inclusion in predictive models would improve accuracy but might reduce the relevance of the assessments. In any case, risk-adjusted LOS should be used as a complementary measure to a suite of ICU performance measures, including structural, process, and outcomes measures of performance, because these other measures may both help to explain variations in ICU LOS and contribute to efforts to improve performance.[33,40,41]

In summary, the APACHE IVrecal and MPM_0 III LOS model are more accurate than the SAPS II LOS model for the prediction of ICU LOS. APACHE IVrecal is the most accurate LOS prediction model for specific ICU subpopulations. This is in part due to its larger number of variables, but it also likely reflects a longer window of data collection (the first 24 h, instead of the first hour, in the ICU). It is the preferred model when either ample resources are available for data collection or the APACHE IV variables can be generated by an electronic medical record, and there are no concerns about treatment impacting measured severity of illness over the first day of treatment. The MPM_0 III LOS model is less accurate, although it performs well across broad hospital populations, imposes less of a data collection burden, uses a shorter data collection window, and, therefore, is less likely to be influenced by treatment. The final choice of a model by physicians, hospitals, quality-reporting groups, or payers must reflect value judgments regarding the balance between predictive accuracy and data burden. Only with a wider application of risk-adjusted LOS and mortality measures will we understand those factors that account for the large observed differences in hospital outcomes and be able to accelerate improvements in ICU care.

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Appendix

Appendix—*Reestimated Coefficients for APACHE IV LOS Model*

Variables	Coefficient Estimation Sample (n = 6,684)	95% CI
Age	0.0078	−0.0234 to 0.0390
Knot = 27	0.000001	−0.00003 to 0.00003
Knot = 51	−0.000059	−0.0003 to 0.0001
Knot = 64	0.00027	−0.0003 to 0.0009
Knot = 74	−0.00066	−0.0016 to 0.0003
Knot = 86	0.0021	−0.0003 to 0.0045
Comorbidity		
None	Reference	Reference
Cirrhosis	−0.0547	−0.8426 to 0.7334
Immunosuppressed	−0.0917	−0.6706 to 0.4873
Cancer, metastatic	−0.2231	−0.8596 to 0.4134
Lymphoma	0.0901	−1.1180 to 1.2981
Hepatic failure	2.3535	1.2357 to 3.4713
AIDS	−0.4178	−1.8666 to 1.0310
Leukemia, myeloma	0.8278	−0.3980 to 2.0537
APS	0.0411	−0.0204 to 0.1025
Knot = 10	−0.000034	−0.0002 to 0.0001
Knot = 22	0.00016	−0.0002 to 0.0006
Knot = 32	−0.00021	−0.0006 to 0.0001
Knot = 48	0.000085	−0.00002 to 0.0002
Knot = 89	0.000001	−0.00003 to 0.00003
PaO_2/FIO_2 ratio	−0.0052	−0.0063 to −0.0041
Ventilated on ICU day 1	1.8966	1.5566 to 2.2366
Admission source		
Other	Reference	Reference
Floor	0.3217	−0.0208 to 0.6643
Other hospital	1.3000	0.6194 to 1.9807
Operating/recovery room	−1.0302	−2.2836 to 0.2233
Emergency surgery	1.1476	0.5190 to 1.7762
Previous LOS	−0.2760	−1.4315 to 0.8795
Knot = 0.121	1.7218	−1.0812 to 4.5249
Knot = 0.423	−3.3143	−8.8047 to 2.1762
Knot = 0.794	1.6265	−1.1756 to 4.4285
Knot = 2.806	−0.0392	−0.1899 to 0.1114
Thrombolytic therapy for AMI	0.3031	−0.6018 to 1.2080
GCS score	0.0215	−0.0214 to 0.0645
Unable to assess GCS	0.7593	0.3503 to 1.1682
Nonoperative diagnostic groups		
Cardiovascular diagnoses		
AMI		
Anterior	0.0926	−0.8988 to 1.0841
Inferior/lateral	−0.2644	−1.2252 to 0.6964
Non-Q wave	−0.6638	−2.2126 to 0.8849
Other	Reference	Reference
Cardiac arrest	1.8213	0.2694 to 3.3731
Cardiogenic shock	0.8254	−0.5682 to 2.2191
Cardiomyopathy	−0.2542	−2.3527 to 1.8442
Congestive heart failure	−0.1450	−0.9686 to 0.6785
Chest pain, rule out AMI	1.0292	−2.1827 to 4.2410
Hypertension	−0.3278	−1.5456 to 0.8899

(Continued)

Appendix—*(Continued)*

Variables	Coefficient Estimation Sample (n = 6,684)	95% CI
Hypovolemia/dehydration (not shock)	−0.5539	−2.9398 to 1.8320
Hemorrhage (not related to GI bleeding)	−1.8497	−4.8867 to 1.1873
Aortic aneurysm, dissecting	1.5569	−0.9018 to 4.0156
Peripheral vascular disease	0.1520	−1.7145 to 2.0185
Rhythm disturbance	−0.3191	−1.1107 to 0.4725
Sepsis		
Cutaneous	0.2151	−1.8327 to 2.2629
GI	0.3856	−1.3586 to 2.1298
Pulmonary	2.2312	0.8886 to 3.5737
Urinary tract	0.6214	−0.5759 to 1.8188
Other	0.0842	−2.9556 to 3.1241
Unknown	0.4545	−0.5199 to 1.4289
Cardiac drug toxicity	0.4403	−1.9391 to 2.8198
Unstable angina	−0.2866	−1.2664 to 0.6932
Cardiovascular, other	−0.0935	−0.9220 to 0.7351
Respiratory diagnoses		
Airway obstruction	−1.1566	−2.5816 to 0.2683
Asthma	−0.9504	−2.4029 to 0.5021
Aspiration pneumonia	1.8594	0.6822 to 3.0366
Bacterial pneumonia	1.3593	0.5127 to 2.2059
Viral pneumonia	11.9734	7.9610 to 15.9858
Parasitic/fungal pneumonia	−0.3144	−2.4677 to 1.8390
COPD	−0.5337	−1.4327 to 0.3653
Pleural effusion	2.3729	0.2764 to 4.4693
Pulmonary edema (noncardiac, ARDS)	1.8502	0.5768 to 3.1236
Pulmonary embolism	0.0365	−1.3239 to 1.3969
Respiratory arrest	5.5090	2.4528 to 8.5652
Respiratory cancer	1.6241	−0.7706 to 4.0187
Restrictive lung disease	−0.3943	−3.4324 to 2.6439
Respiratory, other	0.6541	−0.2716 to 1.5797
GI diagnoses		
GI bleeding, upper	−0.1162	−1.0717 to 0.8393
GI bleeding, lower	0.0846	−1.2942 to 1.4634
GI bleeding, varices	0.0706	−1.1279 to 1.2691
GI inflammatory disease	2.0000	0.1665 to 3.8335
Neoplasm	−0.1524	−2.4206 to 2.1158
Obstruction	−1.5949	−4.4752 to 1.2853
Perforation	2.3205	−2.1588 to 6.7999
Vascular insufficiency	0.3367	−5.9729 to 6.6464
Hepatic failure	1.3973	−0.8488 to 3.6434
Intra/retroperitoneal hemorrhage	−0.0192	−4.0357 to 3.9974
Pancreatitis	−0.0271	−2.1165 to 2.0623
GI, other	1.0184	−0.7128 to 2.7496
Neurologic diagnoses		
Intracerebral hemorrhage	1.1529	0.2131 to 2.0927
Neurologic neoplasm	0.1640	−1.9908 to 2.3188
Neurologic infection	0.2610	−1.4320 to 1.9541
Neuromuscular disease	−0.3268	−2.9793 to 2.3256
Drug overdose	−0.9729	−1.8955 to −0.0502
Subdural/epidural hematoma	0.4392	−1.0542 to 1.9326
Subarachnoid hemorrhage, intracranial aneurysm	2.9454	1.6706 to 4.2203
Seizures (no structural disease)	−0.0589	−1.2930 to 1.1753
Stroke	0.9552	−0.3379 to 2.2483
Neurologic, other	2.3299	0.8984 to 3.7615
Metabolic/endocrine diagnoses		
Acid-base, electrolyte disorder	0.1873	−1.6411 to 2.0156
Diabetic ketoacidosis	−0.6338	−1.6196 to 0.3521
Diabetic HHNC	−0.5630	−1.7594 to 0.6334
Metabolic/endocrine, other	−0.2237	−1.6751 to 1.2277
GU diagnoses		
Renal, other	0.1151	−0.9682 to 1.1983
Miscellaneous diagnoses		
General, other	−0.2454	−1.7009 to 1.2101
Operative diagnoses		
Cardiovascular surgery		
Valvular heart surgery	−1.0431	−2.8156 to 0.7295
Aortic aneurysm, elective repair	0.4275	−1.3497 to 2.2047
Aortic aneurysm, ruptured	0.5937	−4.0943 to 5.2817
Aortic aneurysm, dissection	0.3527	−2.8310 to 3.5364
Femoral-popliteal bypass graft	0.3356	−1.5599 to 2.2311
Aortoiliac, aortofemoral bypass graft	0.9262	−2.5131 to 4.3654
Peripheral ischemia (emobolectomy, thrombectomy, dilation)	−0.4225	−4.6282 to 3.7832
Carotid endarterectomy	0.8925	−0.7279 to 2.5129
Cardiovascular surgery, other	0.1896	−1.5406 to 1.9198
Respiratory surgery		
Thoracotomy, malignancy	0.9806	−0.7279 to 2.6892
Neoplasm, mouth, larynx	1.5202	−0.9609 to 4.0013
Thoracotomy, lung biopsy, pleural disease	4.8600	1.7232 to 7.9968
Thoracotomy, respiratory infection	0.2357	−2.3060 to 2.7774
Respiratory surgery, other	1.7429	−0.0452 to 3.5310
GI surgery		
GI malignancy	1.7652	0.0896 to 3.4409
GI bleeding	0.8628	−1.4034 to 3.1291
Fistula, abscess	−0.8891	−3.8190 to 2.0408
Cholecystitis, cholangitis	−0.0360	−2.0664 to 1.9945
GI inflammation	1.8150	−0.9391 to 4.5692
GI obstruction	0.1693	−1.6523 to 1.9909
GI perforation	2.5490	0.6072 to 4.4909
GI vascular ischemia	5.2939	1.8331 to 8.7548
Liver transplant	−3.1338	−7.3945 to 1.1270
GI surgery, other	0.0103	−1.5726 to 1.5932
Neurologic surgery		
Craniotomy or transsphenoidal procedure for neoplasm	0.7337	−0.8877 to 2.3552
Intracranial hemorrhage	1.8154	−1.0389 to 4.6697
Subarachnoid hemorrhage, intracranial aneurysm	2.9454	1.6706 to 4.2203

(Continued)

Appendix—*(Continued)*

Variables	Coefficient Estimation Sample (n = 6,684)	95% CI
Subdural/epidural hematoma	0.4392	−1.0542 to 1.9326
Laminectomy, fusion, spinal cord surgery	0.7094	−1.0999 to 2.5188
Neurologic surgery, other	0.6249	−1.1605 to 2.4102
Genitourinary surgery		
Renal/bladder/prostate neoplasm	0.2622	−3.2134 to 2.4526
Renal transplant	−2.0178	−7.3254 to 3.2897
Hysterectomy	−0.1985	−3.2134 to 2.8164
Genitourinary surgery, other	0.4942	−1.9733 to 2.9617
Miscellaneous surgery		
Amputation, nontraumatic	−0.3057	−9.2631 to 8.6516
Intercept	2.2550	−4.4486 to 8.9587

Knot = numerical cut point for each splined variable; APS = acute physiology score; FIO_2 = fraction of inspired oxygen; GCS = Glasgow coma scale; AMI = acute myocardial infarction; HHNC = hyperglycemic hyperosmolar nonketotic coma. See Table 1 for abbreviations not used in the text.

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Assessing contemporary intensive care unit outcome: An updated Mortality Probability Admission Model (MPM_0-III)*

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Objective: **To update the Mortality Probability Model at intensive care unit (ICU) admission (MPM_0-II) using contemporary data.**

Design: **Retrospective analysis of data from 124,855 patients admitted to 135 ICUs at 98 hospitals participating in Project IMPACT between 2001 and 2004. Independent variables considered were 15 MPM_0-II variables, time before ICU admission, and code status. Univariate analysis and multivariate logistic regression were used to identify risk factors associated with hospital mortality.**

Setting: **One hundred thirty-five ICUs at 98 hospitals.**

Patients: **Patients in the Project IMPACT database eligible for MPM_0-II scoring.**

Interventions: **None.**

Measurements and Main Results: **Hospital mortality rate in the current data set was 13.8% vs. 20.8% in the MPM_0-II cohort. All MPM_0-II variables remained associated with mortality. Clinical conditions with high relative risks in MPM_0-II also had high relative risks in MPM_0-III. Gastrointestinal bleeding is now associated with lower mortality risk. Two factors have been added to MPM_0-III: "full code" resuscitation status at ICU admission, and "zero factor" (absence of all MPM_0-II risk factors except age). Seven two-way interactions between MPM_0-II variables and age were included and reflect the declining marginal contribution of acute and chronic medical conditions to mortality risk with increasing age. Lead time before ICU admission and pre-ICU location influenced individual outcomes but did not improve model discrimination or calibration. MPM_0-III calibrates well by graphic comparison of actual vs. expected mortality, overall standardized mortality ratio (1.018; 95% confidence interval, 0.996–1.040) and a low Hosmer-Lemeshow goodness-of-fit statistic (11.62; $p = .31$). The area under the receiver operating characteristic curve was 0.823.**

Conclusions: **MPM_0-II risk factors remain relevant in predicting ICU outcome, but the 1993 model significantly overpredicts mortality in contemporary practice. With the advantage of a much larger sample size and the addition of new variables and interaction effects, MPM_0-III provides more accurate comparisons of actual vs. expected ICU outcomes. (Crit Care Med 2007; 35:827–835)**

The use of risk adjustment models to benchmark intensive care unit (ICU) performance has become widely accepted in the past 20 yrs (1). Mortality outcomes are known to depend on a patient's presenting condition, which can be quantified to produce risk-adjusted outcome predictions. Comparison of actual and predicted outcomes is needed for internal quality improvement and is increasingly important with proposals from the Center for Medicare/Medicaid Services to pay for superior performance, with the contemplated public release of ICU outcome data (2), and to satisfy reporting requirements now being considered by the Joint Commission on the Accreditation of Healthcare Organizations and its ORYX Core Measures (3) program.

The Mortality Probability Model at ICU admission version 2 (MPM_0-II) (4) was developed on an international sample of 12,610 patients treated in 1989–1990. Its assessment of patient acuity and likelihood of mortality at hospital discharge is based on measurements obtained within 1 hr of ICU admission. MPM_0-II is an integral part of the ICU self-evaluation and external benchmarking tools provided by Project IMPACT (Cerner Corporation, KS City, MO), which is widely used in North America. All severity models, including the Acute Physiology and Chronic Health Evaluation (APACHE) (5), the Simplified Acute Physiology Score (SAPS) (6), and MPM (4), have required periodic updates. Since recent research using Project IMPACT data suggests that MPM_0-II overpredicts mortality (7), our goal was to develop and validate a revision that included MPM_0-II risk factors and considered new candidate independent

***See also p. 969.**

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variables available in the Project IMPACT database that retained the "on admission" nature of MPM_0-II.

METHODS

Database. Project IMPACT data for patients treated at 135 ICUs at 98 hospitals between October 2001 and March 2004 were analyzed. All but four hospitals were in the United States; three were Canadian and one was Brazilian. Project IMPACT data are to be submitted at least quarterly for all ICU admissions or for a random sample of 50% or 75% of all ICU admissions (8). Data collectors undergo live Web-enabled clinical training, are provided thorough documentation including detailed operational definitions for each data element, and must pass a challenging certification examination before actual data collection and entry can begin. Technical, customer, and clinical support for participant questions is available each business day. User software automatically identifies ICU admissions to be randomized into the unit's sample and performs extensive checks for data accuracy, quality, and completeness that must be passed before record submission for comparative reporting. Additional data checks are performed at the central site, and dialog with participants occurs when questionable data are identified. HIPAA requirements are fully met. Project IMPACT data collection forms with embedded definitions can be downloaded at http://www.cerner.com/public/Cerner_3.asp?id=26503. Other investigators have documented good agreement between the Project IMPACT central database and re-abstracted patient charts (9).

Project IMPACT data were provided for this study without hospital or patient identifiers. The data set was limited to variables needed for this project, for example, MPM_0-II and other candidate independent variables, hospital outcome, and whether the patient record was included/excluded from MPM_0-II calculations. The research protocol was reviewed by the Institutional Review Board at Baystate Medical Center, which waived the need for approval.

To eliminate potential bias from new participants, data analyzed were from ICUs with $\geq$100 patient records in the Project IMPACT database. Records for patients who did not meet MPM_0-II applicability criteria (i.e., cardiac surgery, acute myocardial infarction, burns, patients under the age of 18, and subsequent ICU readmission during a hospitalization) were excluded from analysis. The resulting sample was randomly split into development (60%) and validation (40%) subsets.

MPM_0-II independent variables, as previously defined (4), were used in the update, and a few new candidate variables were also evaluated: a) variables intended to evaluate lead time bias; and b) patient life support ("code") status at ICU admission. Patients with lead time bias were defined as those who were in an acute or chronic care facility immediately before this hospital admission and patients whose time from hospital admission to ICU admission exceeded 1 day. A patient was defined as having full-code status if there were no restrictions on therapies or interventions at the time of ICU admission.

Statistical Methods. The statistical software used was Stata 8.2/SE for Windows (StataCorp, LP College Station, TX). Univariate analysis assessed the relationship of the MPM_0-II independent variables, various representations of lead time bias, and patient location before ICU admission on mortality using Student's *t*-tests and chi-square tests with significance set at $\alpha = .05$.

Multivariate logistic regression with robust variance estimators (10) was performed using variables with a significant univariate relationship to outcome; $p \leq .2$ was required for model entry. (Robust variance estimators provide better variance estimates and confidence intervals in situations where the data may be clustered due to specialized ICUs.) Interactions were considered, because the presence of a particular independent variable can modify the effect of another independent variable in the model. In particular, interactions between age and all other MPM_0-II variables were evaluated, since initial attempts for calibration suggested that age effects were influenced by the presence of comorbidities. Other candidate interactions with clinical "face validity" were tried in a series of stepwise regressions. Interaction effects were included if a model with solely additive effects did not achieve acceptable calibration.

A priori criteria for model performance were an area under the receiver operating characteristics (ROC) curve of $\geq$0.75 (11) and acceptable calibration. Calibration was evaluated with the Hosmer-Lemeshow goodness-of-fit statistic (12), by graphic comparison of actual and expected mortality for equal-sized patient deciles ordered by risk and by calculating the overall standardized mortality ratio (SMR) (ratio of actual to expected mortality) and its associated confidence limits on the validation sample (13). We defined acceptable calibration to occur if the following criteria were met: a) there is a nonsignificant Hosmer-Lemeshow value ($p > .05$); b) the Hosmer-Lemeshow decile calibration plot has a slope and intercept that do not differ significantly from 1 and 0, respectively; and c) the SMR on the validation set is between 0.95 and 1.05 and its confidence intervals include 1. Model terms with low Wald statistics were candidates for removal. We compared nested and nonnested models using the Bayesian information criterion (14), a measure of overall fit that provides evidence favoring one model over another. The model that met the *a priori* performance criteria on the design set and had the strongest support via Bayesian information criterion analysis (14) became our final model.

RESULTS

Some 125,085 patients met the ICU inclusion criteria and were eligible for MPM_0-II scoring. Two hundred records (0.16%) were excluded from analysis because they were missing essential MPM or outcome variables, leaving a database of 124,885 patients. The mean age of this population was 60.8 ($\pm$18.3) yrs vs. 57.0 in MPM_0-II ($p < .001$). The hospital mortality rate was 13.8% vs. 20.8% ($p < .001$) in MPM_0-II. Table 1 describes the study sample. More than half were admitted to the ICU for active treatment or invasive monitoring with the remainder for monitoring or postoperative observation (see Appendix A for definitions of these terms). Almost 42% were admitted from the emergency department: about 30% from the operating room or postanesthesia care unit, 10% from a general care floor, and 5% from a step-down area. Patients transferred from another ICU or hospital together accounted for 6% of admissions, and another 6% of admissions arrived from other healthcare facilities such as rehabilitation centers, long-term ventilation units, or skilled nursing facilities. Twenty-four percent of patients were mechanically ventilated at time of ICU arrival, and almost the same percentage had arterial catheters. Average ICU length of stay was 3.5 days, with a total hospital stay of 11.3 days.

Information on the Project IMPACT ICUs and hospitals contributing to the study database is in Appendix B. Most participants were community, not-for-profit, nonacademic institutions, with the majority having licensed hospital capacity between 200 and 500 beds. A variety of ICU management models are represented; 18% of institutions were teaching hospitals for medical schools, and 23% had accredited critical care fellowship programs.

Some 74,578 patient records (59.7%) were used for model development and 50,307 (40.3%) for model validation. The prevalence of MPM_0-II's independent variables in the Project IMPACT data set, their univariate association with mortality, and comparative data from MPM_0-II are in Table 2. The risk profiles of the two populations differ significantly. Except for hypotension, chronic renal failure, and medical or unscheduled surgical admissions, risk factor prevalence was lower in the current Project IMPACT data set. Significantly, the "risk factor-present" mortality rates in the Project IMPACT sample are substantially lower than in the MPM_0-II sample, with the exception of coma/deep stupor. However,

Table 1. Patient characteristics

Characteristic	No. (%)
Male gender	66,927 (53.1)
Race/ethnicity	
White/Caucasian	96,825 (77.5)
Black/African American/Haitian	16,978 (13.6)
Latin/Hispanic	4,073 (3.3)
Asian/Pacific Islander	1,195 (1.0)
American Indian/Alaska Native	489 (0.4)
Not specified	5,009 (4.0)
Resuscitation status	
Full code at ICU admission	118,491 (94.9)
DNR/no CPR	4,874 (3.9)
Limited Intervention or CMO	1,575 (1.3)
Location before ICU admission	
Emergency department	51,811 (41.5)
Recovery room (PACU)	23,903 (19.1)
Operating room	14,126 (11.3)
General care floor	12,635 (10.1)
Telemetry or step-down unit	6,738 (5.4)
Other hospital—ICU transfer	1,486 (1.2)
Other hospital—ED or floor	6476 (5.2)
Other facility (SNF, LTV, etc.)	7710 (6.2)
Type of ICU patient	
Scheduled/elective postoperative	29,282 (23.4)
Unscheduled/emergency surgery	13,970 (11.2)
Medical/nonoperative	81,633 (65.4)
Primary reason for admission	
Active treatment/invasive monitoring	64,283 (51.5)
Postoperative observation	8,849 (7.1)
Monitoring	51,748 (41.4)
Procedures at ICU admission	
Mechanical ventilation	29,691 (23.8)
Arterial catheters	28,955 (23.2)
Pulmonary artery catheter	4,779 (3.8)
Other statistics	**Mean (SD)**
ICU length of stay, days	3.5 (5.4)
Hospital length of stay, days	11.3 (13.1)

ICU, intensive care unit; DNR, do not resuscitate; CPR, cardiopulmonary resuscitation; CMO, comfort measures only; PACU, postanesthesia recovery unit; ED, emergency department; SNF, skilled nursing facility; LTV, long-term ventilation facility.

the relative risks of death (mortality rate with a risk factor/mortality rate without the risk factor) have remained fairly stable. Differences between the locations of ICUs (MPM_0-II included a significant proportion of European units), the characteristics of patients in the two databases, and the periods they cover have surely contributed to the poor calibration of MPM_0-II when applied to Project IMPACT version 3 data (Fig. 1), confirming the need for a model update.

A model containing only MPM_0-II variables did not meet our criteria for acceptable calibration. We found that 17,448 patients (14%) had no MPM_0-II risk factors other than age. Mortality was overpredicted for this subset of elective surgery patients with no other MPM_0-II risk factors. We thus created a "zero factor" term to allow the model to accommodate the exceptionally low (1.97%) mortality risk in this patient subset. Calibration of the model improved after including the zero factor term.

Univariate analysis found that code status at the time of ICU admission was associated with outcome. Mortality among the 70,747 "full code" patients in the development set was 12.52%, vs. 35.52% for patients with any care limitation ($p < .001$); thus, this variable was added to the model.

Table 3 presents the MPM_0-III logistic regression model. Two new variables, "full code" and "zero factors" have been added, along with seven age interaction terms. Gastrointestinal bleeding, previously a risk factor, now has a negative coefficient and an odds ratio indicating a protective effect. Coefficients for all interaction terms are negative, indicating that the effect on outcome when both factors are present is less than the sum of the effects of the individual factors.

The odds ratios in Table 3 specify the relative mortality risk only for variables not involved in interaction terms. For example, heart rate >150 beats/min has an odds ratio of 1.54, implying that a patient is 1.54 times more likely to die if severe tachycardia is present within 1 hr of ICU admission, all other factors held constant. The interpretation of the odds ratios is more complicated with the presence of interaction terms (also known as effect modifiers). For example, the odds ratio for metastatic neoplasm is not constant over age (hence the inclusion of the "age" interaction term), and the patient's age as well as the presence of this risk factor must be considered when estimating probability of hospital mortality. The effect of age on several risk factors can be observed in Figure 2. The nonparallel logit lines for the selected risk factors over age compared with age alone indicate the presence of interactions.

Discrimination and calibration of the model on the design set met our criteria, with an area under the ROC curve of 0.826 (95% confidence interval, 0.822–0.831) and a Hosmer-Lemeshow statistic of 11.52 ($p = .1740$). Applying this new model to the validation data set, the area under the ROC curve is 0.823 (95% confidence interval, 0.818–0.828), the Hosmer-Lemeshow statistic is 11.62 ($p = .31$), and the SMR is 1.018 with a 95% confidence interval of 0.996–1.040 (13). Figure 1 displays the MPM_0-III and MPM_0-II calibration curves and the 45° line on which actual and predicted mortalities are equal. Actual mortalities closely track MPM_0-III predictions by deciles of predicted risk; the confidence interval for the slope includes 1 (0.98–1.02) and the confidence interval for the intercept includes 0 (−11.34–35.70), fulfilling our criteria for calibration. In contrast, MPM_0-II is poorly calibrated.

DISCUSSION

MPM_0-III estimates mortality probability at hospital discharge using 16 variables obtained at the time of or within 1 hr of ICU admission. The model is based on a large contemporary database whose contributors are primarily North American ICUs. The relatively small data collection burden (binary values for all independent variables except age) is demonstrated by the ability of 135 ICUs to collect and submit data on nearly 125,000 patients in a two and one-half year period. The variables are clearly and objectively defined (4, 8) (Appendix A) and are routinely evaluated for critically ill patients. As with MPM_0-II, no assessments but age are mandatory, and values are assumed to be normal when measurements have not been ordered or

Table 2. Prevalence of Mortality Probability Model version 2 (MPM_0-II) independent variables and relationship to mortality in the Project IMPACT and MPM-II populations

Variable	MPM_0-III (Project IMPACT Data, 2001–2004)				MPM_0-II (Data From 1989 to 1990)			
	Variable Prevalence, %	Mortality When Variable Absent, No. (%)	Mortality When Variable Present, No. (%)	RR	Variable Prevalence, %	Mortality When Variable Absent, No. (%)	Mortality When Variable Present, No. (%)	RR
Physiology								
Coma/deep stupor	6.13	117,231 (10.8)	7654 (59.1)	5.46	11.58	16909 (15.7)	2215 (59.6)	3.80
Heart rate ≥150	2.39	121,905 (13.3)	2980 (32.9)	2.47	2.57	18633 (20.3)	491 (39.5)	1.95
Systolic blood pressure ≤90	16.53	104,236 (10.2)	20,649 (31.9)	3.13	8.69	17462 (17.9)	1662 (50.9)	2.84
Chronic diagnoses								
Chronic renal failure	6.84	116,344 (13.2)	8,541 (21.5)	1.63	4.64	18236 (20.3)	888 (30.1)	1.48
Cirrhosis	3.07	121,050 (13.5)	3835 (23.8)	1.76	3.26	18501 (20.1)	623 (40.8)	2.03
Metastatic neoplasm	4.74	118,963 (13.1)	5922 (26.8)	2.04	6.36	17908 (20.2)	1216 (30.1)	1.49
Acute diagnoses								
Acute renal failure	5.54	117,967 (12.8)	6918 (30.4)	2.38	6.50	17880 (18.3)	1244 (57.2)	3.13
Cardiac dysrhythmia	6.44	116,840 (12.7)	8045 (29.4)	2.32	15.69	16123 (18.1)	3001 (35.0)	1.93
Cerebrovascular incident	4.67	119,051 (13.1)	5834 (27.2)	2.07	8.34	17529 (19.6)	1595 (33.5)	1.71
Gastrointestinal bleed	5.29	118,283 (13.7)	6602 (14.6)	1.07	6.88	17809 (20.0)	1315 (31.6)	1.58
Intracranial mass effect	4.45	119,326 (12.8)	5559 (34.7)	2.71	9.23	17358 (18.7)	1766 (41.2)	2.20
Other factors								
CPR prior to admission	3.26	120,814 (12.6)	4071 (50.5)	4.02	4.28	18305 (19.0)	819 (60.3)	3.17
Mechanical ventilation within 1 hr admission	26.64	91,621 (9.3)	33,264 (26.2)	2.82	49.09	9736 (12.6)	9388 (29.3)	2.33
Medical/unscheduled surgical admit	76.55	29,282 (5.0)	95,603 (16.5)	3.27	69.56	5821 (8.1)	13303 (26.3)	3.24

RR, relative risk; CPR, cardiopulmonary resuscitation.

Some 124,885 patients in the MPM-III database met inclusion criteria and had information on vital status (lived vs. died) and patient type (medical or unscheduled surgical admit); 17,217 died (hospital mortality rate 13.8%) and 107,668 (86.2%) survived.

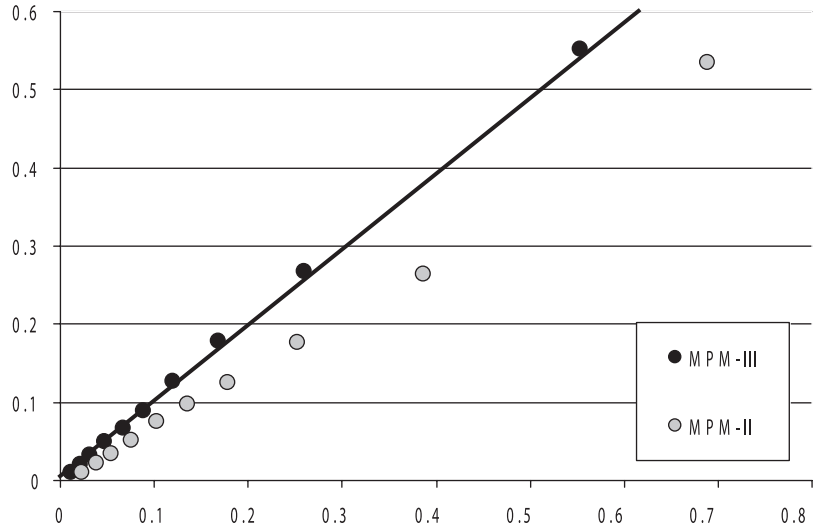

Figure 1. Calibration plot of Mortality Probability Admission Model (*MPM_0-III*) and Mortality Probability Model version 2 (*MPM_0-II*) on 2001-2001 Project IMPACT validation data. Graphic representation of calibration; database collapsed into ten equal sample sizes. *Line at 45 degrees* represents identity, *circles* represent population deciles. The MPM_0-III model (*dark circles*) calibrates well. The *light circles* define the relationship between predicted and actual mortality outcomes when MPM_0-II model is applied to the same dataset (2001–2004 data from Project IMPACT). Actual mortality is below the line of identity except at the lowest deciles of risk, demonstrating that MPM_0-II no longer calibrates.

obtained (4). We believe that the minimal associated manual data collection burden will, in the near future, be even further reduced by automation. Two new model terms were added: "zero factors" (absence of every MPM_0-II risk factor except age) and full resuscitation code status at ICU admission. Both are significantly associated with lower mortality. Zero factor patients are a subset (59%) of elective surgical patients who have only age as a variable for scoring purposes. Our empirical observation is that these patients have low mortality risk, and thus a term is required to reflect these observations. Forty-nine percent of the zero factor patients were admitted to ICU only for monitoring, not active treatment or invasive monitoring. However, zero factor is not synonymous with elective surgery, since 41% of elective surgery patients do have additional risk factors.

MPM_0-III contains seven interaction terms between age and systolic blood pressure ≤90, metastatic neoplasm, cirrhosis, cardiac dysrhythmia, intracranial mass, cardiopulmonary resuscitation, and coma/deep stupor. Interaction terms are needed when the effects of two variables are not additive. Figure 2 shows how the risk associated with three variables changes over age. The interaction coefficients are negative, indicating that as age increases, the marginal effect of the other variable decreases. In other words, presence of comorbidity becomes less important in predicting mortality outcome with advancing age. This finding contradicted our initial expectation that comorbidities would be particularly poor prognostic markers in the elderly. Instead, it seems that comorbidity is already discounted by the existing inverse relationship between age and survival,

Table 3. Mortality Probability Admission Model (MPM_0-III) logistic regression model adjusted odds ratios and coefficients

Variable	Odds Ratios (95% Confidence Intervals)	Coefficients (Robust Standard Errors)
Constant	NA	−5.36283 (0.102)
Physiology		
Coma/deep stupor (GCS 3 or 4)	7.77[a] (5.929, 10.187)	2.050514 (0.138)
Heart rate ≥150 beats/min	1.54 (1.344, 1.770)	0.433188 (0.070)
Systolic blood pressure ≤90 mm Hg	4.27[a] (3.388, 5.375)	1.451005 (0.118)
Chronic diagnoses		
Chronic renal insufficiency	1.71 (1.578, 1.864)	0.5395209 (0.042)
Cirrhosis	7.93[a] (4.679, 13.440)	2.070695 (0.269)
Metastatic neoplasm	24.65[a] (15.583, 39.003)	3.204902 (0.234)
Acute diagnoses		
Acute renal failure	2.32 (2.130, 2.525)	0.8412274 (0.043)
Cardiac dysrhythmia	2.28[a] (1.505, 3.439)	0.8219612 (0.211)
Cerebrovascular incident	1.51 (1.368, 1.663)	0.4107686 (0.050)
GI bleed	0.85 (0.762, 0.943)	−0.165253 (0.054)
Intracranial mass effect	6.39[a] (4.666, 8.760)	1.855276 (0.161)
Other		
Age (per year)	1.04[a] (1.037, 1.041)	0.0385582 (0.001)
CPR before admission	4.47[a] (3.003, 6.652)	1.497258 (0.203)
Mechanical ventilation within 1 hr of admission	2.27[a] (2.155, 2.401)	0.821648 (0.028)
Medical or unscheduled surgical admit	2.48 (2.267, 2.721)	0.9097936 (0.047)
Zero factors (no factors other than age from list above)	0.65 (0.551, 0.776)	−0.4243604 (0.087)
Full code	0.45 (0.415, 0.490)	−0.7969783 (0.043)
Interaction terms		
Age × coma/deep stupor	0.99 (0.988, 0.997)	−0.0075284 (0.002)
Age × systolic blood pressure ≤90	0.99 (0.988, 0.995)	−0.0085197 (0.002)
Age × cirrhosis	0.98 (0.969, 0.986)	−0.0224333 (0.005)
Age × metastatic neoplasm	0.97 (0.961, 0.974)	−0.0330237 (0.004)
Age × cardiac dysrhythmia	0.99 (0.984, 0.996)	−0.0101286 (0.003)
Age × intracranial mass effect	0.98 (0.978, 0.988)	−0.0169215 (0.002)
Age × CPR prior to admission	0.99 (0.983, 0.995)	−0.011214 (0.003)

NA, not applicable; GCS, Glasgow Coma Scale; GI, gastrointestinal; CPR, cardiopulmonary resuscitation; ×, interaction between variables listed.

[a]For these variables, the odds ratios are also affected by the associated interaction terms. Validation sample size = 50,307; Hosmer-Lemeshow goodness-of-fit test statistic = 11.62, receiver operating characteristic curve = 0.823, standardized mortality ratio = 1.018.

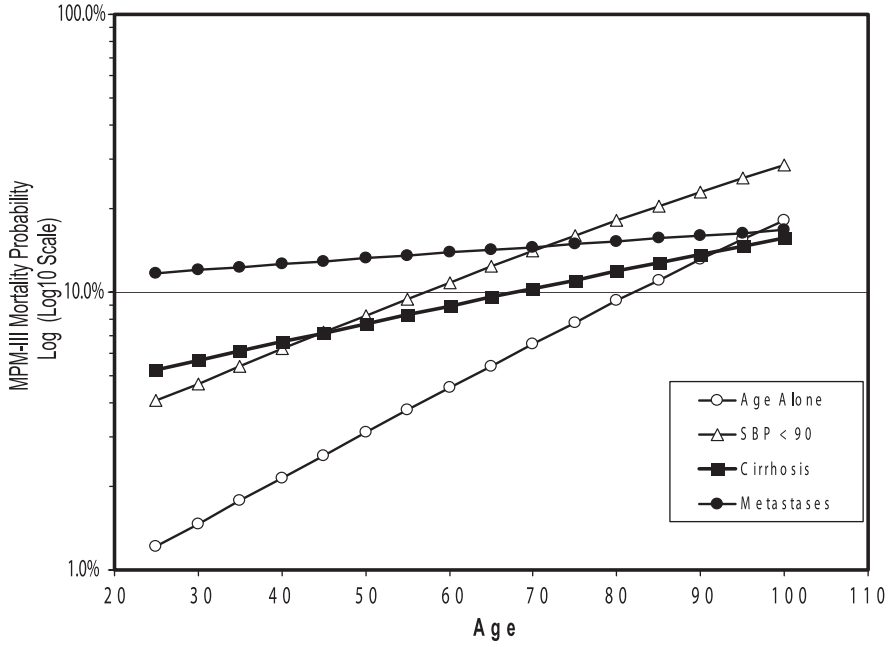

Figure 2. Mortality probability: Effect of interaction terms. *SBP*, systolic blood pressure; *MPM_0-II*, Mortality Probability Admission Model.

whereas in young patients they exert a larger relative effect. ICU admission is uncommon in the young (trauma and toxic ingestion being the usual precipitants), and in this database 89% were older than 35. So admission for a critical illness in these younger patients often indicates a life-threatening event related to a comorbidity (e.g., metastatic cancer, cirrhosis, or brain injury) rather than transient hemodynamic or respiratory instability that may prompt admission in some elderly with less physiologic reserve. In addition, some illnesses (e.g., breast cancer) tend to be slowly progressive in the elderly but more aggressive in younger individuals (15).

When applied to the contemporary Project IMPACT version 3 database, MPM_0-II significantly overpredicts severity-adjusted hospital mortality. Thus, an updated model was necessary. A previous update of MPM_0-II that did not reevaluate the contributions of individual variables had good performance on the Project IMPACT version 2 (pre-2001) database but did not perform well on version 3 (2001 to the present) data (16). This finding suggested that the relative contribution of the individual MPM_0-II variables might have changed. In our revised model, all prior (MPM_0-II) risk factors still have odds ratios that differ significantly from 1. However, the odds ratio for gastrointestinal bleeding (previously >1, indicating increased mortality risk) now indicates lower mortality risk (odds ratio <1) when this variable is considered in the context of other risk factors. As patients with gastrointestinal bleeding may be admitted to the ICU for logistic reasons (e.g., ability to conduct endoscopy in a monitored setting), a differing threshold for admission may now be influencing the relative mortality risk. Early intensive resuscitation (17) and changes in management (18) (reduced use of balloon tamponade and increased use vasoactive drugs, rapid endoscopic treatment, proton pump inhibitors, and antibiotic prophylaxis) in the past 15 yrs may also be playing a role. Changes in risk profiles over time have been documented for ICU (19) patients, presumably the result of improving medical care, although differences in patient populations cannot be excluded. Advances in chemotherapy and radiation therapy have altered the expected outcome of metastatic disease. Triage differences may also affect the population receiving intensive care. The

ETHICUS study (20) suggests that care limitation is more likely with neurologic than other diagnoses, which may affect the relative risk of coma as a mortality risk factor. Because care limitations specified at the time of ICU admission affect hospital survival, we felt it was important to add a term for "full code" status to the revised model.

Advantages of MPM_0-III. An advantage of the MPM_0-II and III models is that users need not specify a particular diagnosis to apply them. This avoids the need to select among multiple important diagnoses for a complex patient and the attendant calibration issues that arise with misclassification (21). MPM_0-III has good discrimination (area under the ROC curve = 0.823) and calibration assessed visually (Fig. 1) and by the overall SMR. The MPM_0-III Hosmer-Lemeshow statistic is 11.52, a substantial improvement compared with the value of 1361 when MPM_0-II is applied to the validation data set. We believe that the Project IMPACT version 3 sample, compared with the MPM_0-II database, is more representative of current North American practice and that the MPM_0-III model developed from this database provides a more accurate contemporary benchmarking tool. A free MPM_0-III calculator can be downloaded from www.cerner.com. Appendix C provides an example of how to calculate an MPM_0-III score manually.

MPM_0 provides an assessment of acuity based on age and 15 binary variables measured at the time of or within 1 hr of ICU admission, whereas SAPS and APACHE are heavily based on extreme physiologic values obtained during the patient's first 24 hrs in the ICU. MPM_{24}-II, which takes into account the first 24 hrs of ICU care, more closely parallels the APACHE and SAPS constructs (22). We did not update MPM_{24} because the other severity models cover this later time period. Thus, the MPM_0 characterization is based on patient condition largely *before* ICU care begins, and since one objective of such models is to estimate "quality of care" by assessing risk-adjusted patient outcomes, the MPM_0 precare construct is useful and appropriate. It can also be used to evaluate the appropriateness of ICU admissions, patient flow, and resource use. MPM_0 is also an integral part of the "Rapoport–Teres methodology" (13) used by Project IMPACT to graphically evaluate and compare one ICU's severity adjusted survival and resource use with those of other participating ICUs treating a similar case mix (8). This research team is also updating the resource use metric using Project IMPACT data.

Limitations of MPM_0-III. The MPM_0 construct does have limitations, for example, for patients whose condition is rapidly changing as they are admitted. MPM excludes certain patient subsets (e.g., cardiac surgery, myocardial infarction, and ICU readmissions), which reduces its usefulness to some ICUs. Also, MPM_0's discrimination is somewhat lower than that of APACHE III and SAPS II, which have reported areas under the ROC curve of up to 0.90 (5). As with MPM, APACHE and SAPS have undergone recent revision, and APACHE IV (23) and SAPS III (24) both attain better discrimination, as measured by area under the ROC curve. MPM data are collected at ICU arrival, resulting in less potential for the score to be influenced by care it is intended to measure. However, the cost of this simplicity and timeliness is a reduction in discrimination compared with other models. The extent to which ICU care modifies scores is unknown and likely variable, so for purposes of comparing ICUs or care systems, less discrimination may be an acceptable tradeoff for a metric unaffected by ICU care.

Project IMPACT participants are self-selected, which might limit application of the MPM_0-III model to other settings. In particular, MPM_0-III was developed on a North American database; thus, its relevance to populations outside North America will require additional evaluation (25). We anticipate the use of MPM_0-III in retrospective, unit-wide evaluations and external comparisons by Project IMPACT, which are made among units having similar case mixes (8).

Because mortality rate varies by patient type, both the raw (unadjusted) and severity-adjusted mortality rates of a critical care unit will vary as a function of case mix. For example, in this data set, medical, trauma, and elective surgical patients had mortality rates of 16.9%, 11.2%, and 5.3%, respectively. In MPM_0-II, case mix differences were handled by segmenting patients into three broad categories—elective surgical, medical, or emergency surgical—including a single term in the model (medical/unscheduled surgical admission) to adjust outcomes. Based on our analysis of the 135 ICUs in this database, there are situations where the case mix is so unusual (e.g., dedicated trauma units) that the use of a specialized model might be appropriate. Case-mix effect has been demonstrated experimentally by Murphy-Filkins and colleagues (26). We are currently developing specialized subgroup models for the complex cardiovascular, trauma, neurosurgery, and emergency surgical populations as well as the case-mix thresholds or other situations when these models should be utilized.

We found the relationship between "lead time" (time from hospital admission to ICU admission) and outcome to be complex. Nonsurvivors had longer average lead time than survivors (2.3 days vs. 1.03 days; $p < .001$) in the univariate analysis. However, lead time effect differed by patient type and had inconsistent effects on outcome. Trauma patients, for example, had very short lead times regardless of outcome, whereas neurosurgical and elective surgery patients had long lead times but low average mortality. APACHE III (5) includes terms for both lead time and pre-ICU location, to control for intensive care initiated before ICU admission (27), which may alter the relationship between physiologic scoring and outcome (28). Although we were aware of lead time effects on mortality prediction (29), we were unable to include a lead time variable that improved model calibration. The granularity of the time between hospital and ICU admission, which was recorded in days rather than hours, may also have influenced our results. Furthermore, our analysis suggests that lead time may need to be adjusted by patient category as well as location before ICU admission, as we did note outcome differences in selected subgroups, which we plan to report separately. Location before ICU admission did not enter our model; we suspect that the way the data are captured (allowing one choice among many; Table 1) makes it difficult to categorize a patient who is admitted through the emergency department, undergoes an operation, and is boarded in a postanesthesia care unit before receiving an ICU bed.

As with any model predicting ICU outcome, MPM_0-III is intended to evaluate groups of patients and cannot be expected to precisely reflect acuity or predict outcome for individual patients. Thus, it would be inappropriate to use this or any similar model to plan treatment or admission to the ICU based on an estimated probability of death, without considering

many other factors including patient and family preferences, risk factors that are not scored (e.g., malnutrition, bedridden status, patient's will to live), and the capabilities of the ICU, its doctors, and other healthcare providers. Even a low estimated probability of death should not preclude ICU admission where close monitoring and increased nursing attention may be necessary to actually achieve survival.

CONCLUSIONS

The outcomes of contemporary Project IMPACT version 3 patients are substantially better than MPM_0-II predictions that are based on data from patients treated more than a decade earlier. Hospital mortality continues to be a function of the MPM_0-II risk factors, but both the incidence and effect of factors on predicted outcome have changed over time. This requires an updated model for meaningful evaluations, external comparisons, and benchmarking, which we have developed and validated on a large randomly split sample. Only one additional collected variable (code status) has been added to those in MPM_0-II. MPM_0-III discriminates well between hospital survivors and nonsurvivors and has good calibration using visual comparisons of actual and expected mortality, overall SMR, and Hosmer-Lemeshow goodness-of-fit.

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APPENDIX A: DEFINITION OF TERMS

Coma/Deep Stupor. Coma corresponds to a Glasgow Coma Scale score of 3, no response to any stimulation, no twitching or movement in extremities, and no response to pain or command. Deep stupor corresponds to a Glasgow Coma Scale of 4 or 5 and decorticate or decerebrate posturing. Definition excludes patients whose condition is due to drug overdose. For patients receiving paralytic agents, sedation, or awakening from anesthesia, best clinical judgment of the level of consciousness before medication should be used.

Heart Rate. A heart rate of $\geq$150 beats/min must be documented within 1 hr before or after ICU admission.

Systolic Blood Pressure. A systolic blood pressure $\leq$90 mm Hg must be documented within 1 hr before or after ICU admission.

Chronic Renal Failure. This requires medical history of chronic renal compromise with most recent creatinine >176 μmol/L (2.0 mg/dL).

Appendix B. Characteristics of study hospitals (98) and intensive care units (ICUs) (135)

	%
Distribution of ICUs by AHA region	
New England	11.3
Mid-Atlantic	8.2
South Atlantic	17.5
East North Central	28.9
West Central	22.7
West and Mountain	11.4
Hospital class	
Rural	14.1
Suburban	36.4
Urban	49.5
Hospital organization	
Academic (university-based)	15
Community, for profit, nonacademic	8
Community, not-for-profit, nonacademic	73
City/county/state	4
Teaching hospital for medical school-	18
Accredited critical care fellowship	23
Size of participating ICUs, beds	
<10	3.7
10–15	48.9
16–19	23.0
≥20	24.4
Distribution of patients by patient type	
Medical coronary care	6.6
Trauma	8.5
Elective surgery (not cardiac or neurosurgery)	19.5
Medical (including requiring minor surgery)	49.8
Medical patients requiring major surgery	2.9
Emergency surgery	7.3
Neurosurgical	4.6
ICU medical team model	
Mandatory critical care management	11.7
Mandatory critical care consult	8.5
Patient transfered and managed by CC team	7.4
CC consult at discretion of attending	38.3
CC management at discretion of attending	31.9
No CC physician available	2.1

AHA, American Hospital Association; CC, critical care.

Cirrhosis. This requires history of portal hypertension and varices or biopsy confirmation.

Metastatic Neoplasm. This includes stage IV cancer, excluding regional lymphatic spread. A diagnosis requires obvious metastases by clinical assessment or pathology report. It includes acute hematologic malignancies and excludes chronic leukemia unless there are findings attributable to the disease (sepsis, anemia, tumor lysis syndrome, lymphangiectatic form of acute respiratory distress syndrome) or the patient is under active treatment for leukemia.

Acute Renal Failure. This includes acute tubular necrosis and acute decompensation of chronic renal failure. It excludes prerenal states.

Cardiac Dysrhythmia. This includes acute change in heart rhythm, including paroxysmal tachycardia, atrial fibrillation with rapid ventricular response, second- or third-degree heart block, and ventricular dysrhythmias. It excludes chronic, stable arrhythmias.

Cerebrovascular Incident. This includes an acute diagnosis of cerebral embolism, occlusion, cerebrovascular accident, stroke, brain stem infarction, and cerebrovascular arteriovenous malformation with acute stroke or hemorrhage.

Intracranial Mass Effect. This includes abscess, tumor, or intracranial or subdural hemorrhage identified by computed tomography or other imaging and associated with any of the following: midline shift, obliteration or distortion of cerebral ventricles, gross hemorrhage into the cerebral ventricles or subarachnoid space, visible mass >4 cm, or any mass that enhances with contrast media.

Gastrointestinal Bleed. This includes new-onset melena or hematemesis associated with a clinically plausible decrease in hemoglobin values. It excludes an unexplained decrease in hemoglobin without other evidence or perforated ulcer without evidence of bleeding.

Cardiopulmonary Resuscitation Within 24 Hrs Before ICU Admission. This includes chest compression, defibrillation, or cardiac massage. It excludes emergent intubation without cardiac resuscitation or electrical stimulation of the heart as a planned procedure (e.g., open heart surgery, electrophysiologic studies).

Mechanical Ventilation. Patient is on a mechanical ventilator within 1 hr of ICU admission. This excludes bilevel positive airway pressure (BiPAP) ventilation unless delivered via tracheostomy.

Medical or Unscheduled Surgical Admission. This includes all patients except those admitted following an elective surgical procedure (i.e., scheduled ≥24 hrs in advance). Elective preoperative admission (e.g., for pulmonary artery catheter) for a scheduled operation is also excluded.

Full Code. This includes no restrictions on emergency therapies or interventions. It excludes patients with do-not-resuscitate or do-not-intubate orders.

Active Treatment or Invasive Monitoring. This includes any medical/invasive intervention usually performed in the ICU, required to respond to a patient's acute disease process or prevent further deterioration. It includes pulmonary artery catheter, arterial catheter, central venous pressure monitors, intracranial pressure monitors, vasopressors, or mechanical ventilation.

Postoperative Observation. This includes postoperative patients requiring close monitoring, but not active treatment. Routine femoral-popiteal bypass, craniotomy, or carotid endarterectomy patients with no sequelae would fall into this category.

Monitoring. This category includes stable overdose patients, suicide precautions, or others requiring close observation who do not fit into "active treatment or invasive monitoring" or "postoperative observation" as defined previously.

APPENDIX C: EXAMPLE OF CALCULATING THE MPM_0-III SCORE ON AN INDIVIDUAL PATIENT

The following hypothetical patient illustrates how the mortality probability is derived from the "all patient" model.

A 60-yr-old female with a bleeding gastric ulcer refractory to endoscopic therapy is admitted after emergency surgery to control bleeding. Her past medical history is negative for cirrhosis, renal failure, or metastatic cancer. Her "code" status is full, and

she arrives with a blood pressure of 88/60 and a heart rate of 120, breathing spontaneously after extubation on the operating table. The logit of her mortality probability incorporates the constant, a term for gastrointestinal bleeding, her age, medical or unscheduled surgical admission, recognition of her "code" status, hypotension, and the interaction between age and hypotension:

$$-5.36283 - 0.165253 + (60 \cdot 0.0385582) + 0.9097936 - 0.7969783 + 1.451005 + (60 \cdot -0.0085197) = -2.16195 \quad [1]$$

To find her mortality probability, solve for the logit term as follows:

$$P_{mortality} = \exp(-2.162)/(1 + \exp[-2.162]) = 0.103 \text{ or } 10.3\% \quad [2]$$