Use of conditionally essential amino acids and the economic burden of postoperative complications after fracture fixation: Results from an economic model

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Objective

To measure the economic impact of conditionally essential amino acids (CEAA) among patients with operative treatment for fractures.

Conclusions

Use of CEAA after operative treatment for fracture fixation leads to cost savings and improve quality of life, as it reduces complications after surgery, which more than offsets the additional cost of CEAA.

CEAA use may become increasingly attractive to US health care system as reimbursement is increasingly linked to both quality of care and cost.

Background

- *Despite significant advancements, surgical treatment of pelvis and extremity fractures can result in various complications, including nonunion complications, venous thromboembolism, surgical site infections, and malnutrition, which can increase the total cost of care for fractures.[1-2]*
- *Supplementation of conditionally essential amino acids (CEAA) has the potential to reduce muscle atrophy and complications during the recovery phase after trauma and can improve various clinical outcomes such as reducing overall complications, including the number of infective episodes, postoperative skeletal muscle loss, and nonunion.[3-4]*

Methods

Model Overview

- *The study modeled the economic impact of using CEAA in addition to postoperative standard of care on complications after operative fracture fixation in an inpatient setting.*
- *Economic impact was estimated by multiplying the likelihood of developing each complication and the corresponding treatment cost, obtained from the literature. The impact of CEAA on complications was derived by taking the difference in the resulting economic impact between baseline and CEAA scenarios net of CEAA cost.*
- *The negative quality of life impact of each complication were estimated using quality-adjusted life years (QALY) estimates obtained from the literature.*
- *The net monetary benefit of CEAA was calculated as the sum of cost savings and monetary benefit of QALYs gained per person net of CEAA costs.*

Model Structure

- *A decision tree model was used to estimate the impact of CEAA use on complication rates and associated health economic outcomes.*
- *The health economic outcomes are modeled as the direct cost savings from changes in complication rates as a result of CEAA intake.*
- *A clinical study by Hendrickson et al. (2022)[1] was used to estimate the likelihood of complications for CEAA and baseline scenarios; this study included a broad range of fractures and examined specific post-surgical complication rates at a single level 1 trauma center.*

Table 1: *PICOTS Criteria of Model*

Population	Adult patients aged ≥18 years with operative treatment of fractures of the pelvis and extremities at trauma center
Intervention	Conditionally essential amino acid (CEAA) supplementation (e.g., Juven®)
Comparator	Standard of care with standard nutrition (no CEAA)
Outcomes	*Clinical (measured at 12 months):* • Overall complications • Medical complications • Non-union • Mortality • Surgical Site Infection • Reoperation *Quality of life:* • Quality of life measure for each of the complications above *Health economic:* • Costs associated with medical complications, non-union, surgical site infection, and reoperation • QALYs gained based on mortality impact and quality of life decrement due to complications
Timing	• 1 year
Setting	• Payer

Table 2: *Abbreviated Table of Model Inputs*

PARAMETER	VALUE	SOURCE
Complication Rates (CEAA and No CEAA)	See Figure 1	Hendrickson (2022)[4]
Complication Cost Parameters		
Overall Medical Complications	$24,339	
Nonunion	$37,670	Antonova (2013)[5]
Surgical Site Infection	$26,803	Zimlichman (2013)[6]
Reoperation	$98,817	Gwam (2017)[7]
Total Population with Operative Fracture Fixations	64,507	Calculated using U.S. Census Bureau, GBD 2019 Fracture Collaborators (2019)[8], Woon et al. (2017)[9], Sporer et al. (2006)[10], Bell et al. (2011)[11]
Health State Utility by Complication Type	0.102 to 0.790	Matza et al. (2019)[12], Sullivan et al. (2009)[13], Schottel et al. (2015)[14] Whitehouse et al. (2002)[15], and Shiri et al. (2019)[16]
Value of a QALY	$150,000	ICER Value Assessment Framework[17]
CEAA Costs	$37.80	Abbott Laboratories[18]

Results

- ***CEAA resulted in incremental costs savings of $4,902 per patient due to fewer complications.***
- *The per-patient cost of complications with CEAA use was $12,215 compared to $17,118 without CEAA use. Cost savings were driven by reductions in nonunion complications, reoperation, medical complications, and surgical site infections. (Figure 2)*
- *Patient quality of life increased by 1.8% with CEAA use, resulting in a net monetary benefit of $6,852 per patient with operative treatment for fracture fixation. Specifically, the QALYs under CEAA use and no CEAA use were 0.739 and 0.726 per person, respectively. (Table 3)*
- *Extrapolating these results to the 64,507 traumatic fracture fixations per year in the US, total cost savings were $316 million, QALYs gained were 813 valued at $150,000/QALY, for a total impact on the economy of $438 million, indicating that CEAA use dominates standard of care as it resulted in net cost savings and improved quality of life.*

Sensitivity Analysis

- *The results of the model were most sensitive to improved overall complication rates for CEAA and least sensitive to changes in cost of UTI events.*
- *The largest changes in the results were observed when the overall complication rates for CEAA were improved. The lower and upper bound of overall complications rates resulted in an 85% decrease and a 56% increase in cost savings, respectively.*

Table 3: *Per Person Costs and QALYs Comparing CEAA Use and Standard of Care (No CEAA Use)*

	CEAA	Standard of Care (i.e., no CEAA)	Incremental Value
Total Costs	$12,215	$17,118	($4,902)
Total QALYS	0.739	0.726	0.013
Monetary Benefit of QALYs Gained	$110,850	$108,900	$1,950
Net Monetary Benefit of CEAA			$6,852

Figure 1: *Clinical Complications: Overall and by Type (Source: Hendrickson et al.)*

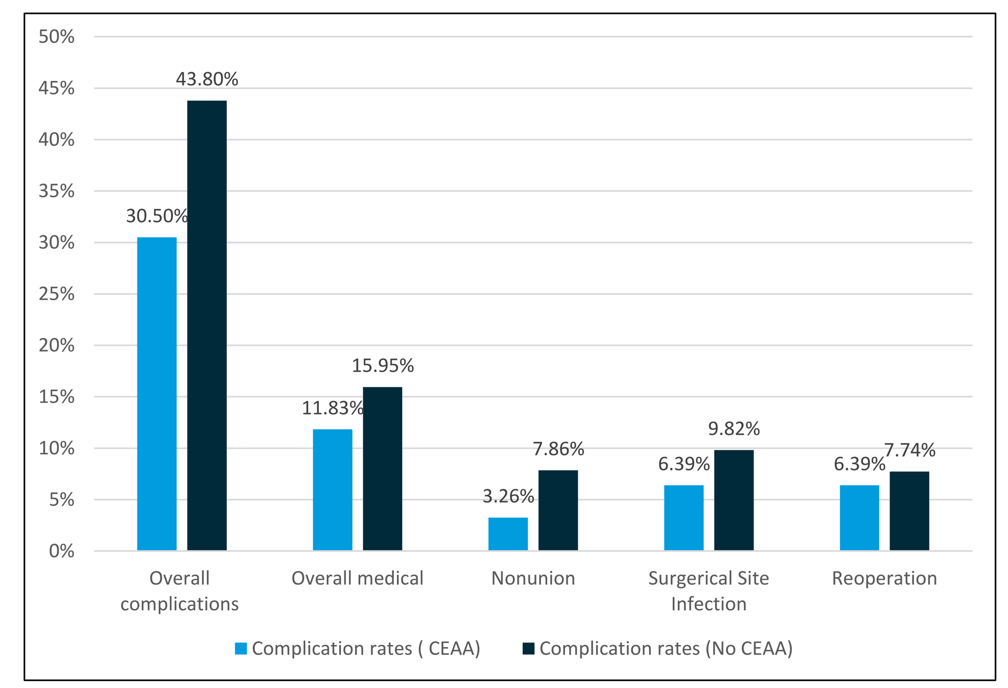
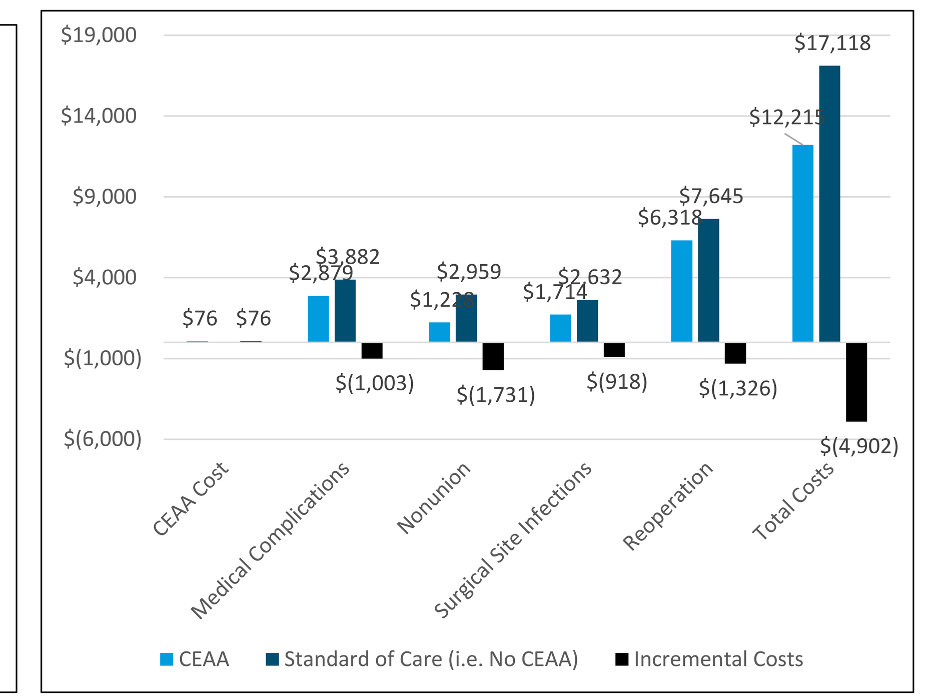


Figure 2: *Per Person Incremental Costs Comparing CEAA Use and Standard of Care (No CEAA Use)*



Discussion

- *CEAA use can decrease postoperative complications and save costs for patients requiring operative fracture fixation, with an estimated average cost reduction of $4,902 per patient and a QALY benefit valued at $1,926 per patient.*
- *Value-based bundled payment schemes, such as CMS's Comprehensive Care for Joint Replacement program, may better align incentives for hospitals and providers to use CEAA supplementation to reduce costs and improve quality of care.*
- *This is the first study to quantify the economic impact of CEAA use among patients indicated for operative fracture fixation. Strengths include analysis of complication rates by type and its use of a recent clinical impact study to estimate the impact of CEAA supplementation.*
- *Limitations include lack of data on specific medical complication types in Hendrickson et al. (2022)[4], potentially conservative estimates due to a focus on the inpatient setting and excluding outpatient cases, and potential limited generalizability because clinical evidence derived from a single level-1 trauma center in America.*

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