A multi-phase, mixed methods evaluation of a machine learning screening tool for malnutrition

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Importance

- Malnutrition is common & underdiagnosed in hospital patients
- It is associated with increased morbidity, mortality, & healthcare costs
- Early detection is important for timely intervention
- Hospitals are required to screen for malnutrition
- Machine learning (ML) technology is appealing for screening
- Registered dietitians (RDs) conduct malnutrition assessment

Phase 1-Quantitative

Developed, tested, and evaluated ML classifier (MUST-Plus) to screen for malnutrition using a retrospective cohort of data from one large, urban healthcare facility

Key Stakeholders/Roles

Hospital administration (promoted ML tool development)
Frontline physicians (provided input on nutrition-related guidelines & malnutrition documentation)
Data scientists (developed, trained, tested tool, trained RDs)
RD leaders (input on interface development, trained RDs)
RDs (feedback on interface & output)

Key Findings

MUST-Plus superior to previously used screening tool:
73% sensitivity (30% higher)
77% specificity (6% higher)
84% AUC (17% higher)

Publication

Timsina P, Joshi HN, Cheng FY, et al. MUST-Plus: A machine learning classifier that improves malnutrition screening in acute care facilities. J Am Coll Nutr. 2021 Jan;40(1):3-12. doi: 10.1080/07315724.2020.1774821. Epub 2020 Jul 23. PMID: 32701397.

Led to

Expansion of MUST-Plus over 2 year period to 5 other facilities serving diverse patient populations

Phase 2-Qualitative

Evaluated implementation into RD clinical workflow (post implementation) across multiple facilities

Semi-structured qualitative interviews
17 RDs interviewed of 24 approached (70.8%), representing 36.9% of RDs using MUST-Plus output
Interviewed via Zoom, 40 minutes
Transcribed verbatim, coded by team, iteratively analyzed, theme tables developed

Key Stakeholders

Evaluation scientists/Qualitative researchers (designed/conducted study, wrote/presented findings)
Data scientists, Hospital administration, RD leaders (provided question input/ contributed to writing/presentation)
RDs (participated in study)

Key Findings - Workflow
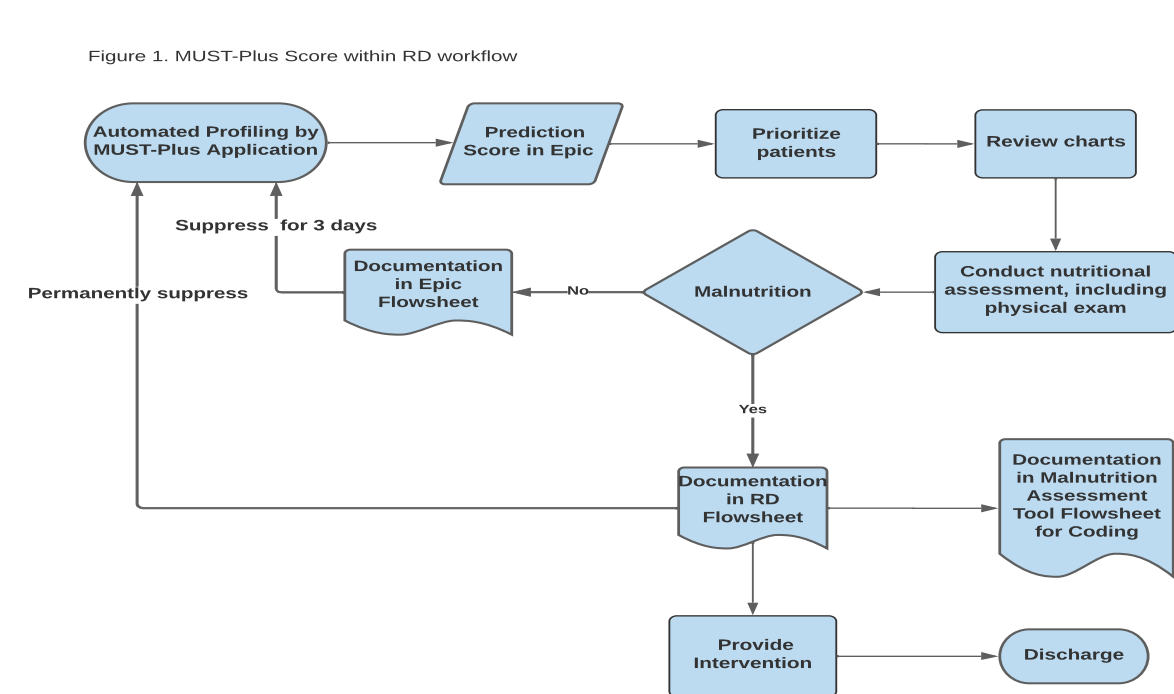
"[The score] is less defining how long we're spending with the patients and more defining who we are seeing. I do think that it is helping us capture malnutrition patients earlier."

Malnutrition Prediction

Score: 0.66 (HIGH)

Top Factors Contributing to Score:
BMI: 20.97
ALBUMIN: 3.4
AGE: 68.0
HEIGHT: 157.48
LOS: 0.52
HEMOGLOBIN: 9.3
PLATELETS: 25.0
RBC: 3.23
K: 3.2
BUN: 15.0

Theme	Key Findings	Exemplary Quotes
Usefulness	- All RDs reported that MUST-Plus was useful - Degree of usefulness varied by respondent-those at the original hospital tended to find it more useful	"I think it's really useful. I think we definitely capture a lot of malnutrition now…I do think it works and it helps us to catch more of these patients with malnutrition."
Accuracy	- RDS perceived the tool to be 50-70 percent accurate - Accuracy improved over time and RDs appreciated fewer false alarms	"…when it first got rolled out, it was not as…specific… we were getting a high score on a lot of our patients, but now it's… more specific."
Understanding & Scale-up	- All RDs could articulate a basic understanding of MUST-Plus - RDS at the original site and higher-level staff seemed to have a deeper understanding - Education may improve understanding	"Albumin, potassium. I have no idea why those are part of the prediction score…" "I wish I knew exactly how it worked or how the algorithm captures these patients."
Improvement	- A single screening tool is ideal	"Right now it feels like we have so many screening tools, if there was…[the] ability to kind of streamline it to using just one, like let's say just the prediction model and not the MST in addition to it…"

Publication

Besculides M, Mazumdar M, Phlegar S, Freeman R, Wilson S, Joshi H, Kia A, Gorbenko K. Implementing a machine learning screening tool for malnutrition: Insights from qualitative research applicable to other ML-based CDSS. JMIR Formative Research. https://preprints.jmir.org/preprint/42262

Phase 3-Quantitative

Assessed outcomes across six facilities:
Productivity rates:
usability Do RDs use the score?
(visited by RD/predicted high risk)
success How accurate is the prediction?
(RD identified MLN/predicted high risk),
documentation How often do RDs record MLN in flow sheet? (MLN recorded in flowsheet/qualifying baseline hospitalizations)
Impact: admission to diagnosis lag, rate of diagnosis

Key Stakeholders/Roles

Data scientists (conducted analysis, contributed to writing)
Evaluation scientists (Interpreted data, Wrote findings)
RD leaders (Helped improve data quality, contributed to writing)
Hospital administration (promoted QI efforts, contributed to writing)

Key Findings

MUST-Plus was successfully scaled & improved outcomes:
Usability rate-all facilities above 90%
Success rate-all facilities above 40%
Documentation improved
Admission to diagnosis lag improved
Rate of diagnosis increased

Publication (under review)

Pramathamesh P, Besculides, Zhan S, Cheng FY, Timsina P, Cheertirala SN, Kersch L, Wilson S, Freeman S, Reich D, Mazumdar M, Kia A. Malnurition risk assessment using a machine learning-based screening tool: A multicenter retrospective cohort study.

Next steps

Improve documentation rates
Conduct follow-up survey on usefulness, accuracy