

SUPPLEMENTARY DATA

Influence of Frailty on Outcome in Older Patients Undergoing Non-Cardiac Surgery – A Systematic Review and Meta-Analysis

Elke K.M. Tjeertes¹, Joris M.K. van Fessem¹, Francesco U.S. Mattace-Raso², Anton G.M. Hoofwijk³, Robert Jan Stolker¹, Sanne E. Hoeks^{1*}

¹Department of Anesthesiology, Erasmus MC University Medical Center, Rotterdam, the Netherlands

²Department of Internal Medicine, Division of Geriatric Medicine, Erasmus MC University Medical Center, Rotterdam, the Netherlands

³Department of Surgery, Zuyderland Medical Center, Geleen, the Netherlands

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Supplementary Table 1. Frailty assessment tools in detail.

Instrument	Description	Items	Range	Suggested Cut-off	Studies
Frailty Index (FI) / Canadian Study of Health and aging frailty index (CSHA-FI) / Frailty index of accumulated deficits (FI-CD)[23]	Index of accumulated health deficits in the physical, cognitive, functional and social realms (symptoms, signs, disabilities, laboratory, radiographic) out of a list of 70 deficits	70	0-1	Not frail ≤ 0.25 Frail > 0.25	[44, 45]
Groningen Frailty Index/indicator (GFI) [46]	(Self-reporting) questionnaire in 4 domains: physical, cognitive, social and psychological	15	0-15	Not frail < 4 Frail ≥ 4	[47-52]
Hopkins Frailty Score / Fried Frailty criteria / (Fried's) Frailty phenotype (FP) [25]	Defining phenotype of frailty by identifying criteria: unintentional weight loss, exhaustion, low energy expenditure, low grip strength, and slowed waking speed	5	0-5	Not frail: 0 (-1) Pre-frail: (1-) 2 Frail ≥ 3	[53-63]
Modified Frailty Index (mFI) [22]	Modification of the CSHA-FI, 11 variables: diabetes mellitus, functional status index of ≥ 2 , COPD or pneumonia, congestive heart failure, myocardial infarction, percutaneous coronary intervention and/or stenting or angina, hypertension requiring medication, peripheral vascular disease or ischemic rest pain, impaired sensorium, TIA or CVA, and CVA with deficit	11	0-1	Not frail: 0 Intermediate frail: 0.09-0.18 Frail ≥ 0.27	[33, 35, 36, 64-84]
(Reported) Edmonton Frail Scale ((R)EFS) [85]	Questionnaire/test on 9 domains (mood, functional independence, medication use, social support, nutrition, general health status, continence); two performance-based test: Clock test for cognitive impairment and 'Timed Get Up and Go' for functional performance	11	0-17	Not frail: 0-5 Vulnerable: 6-7 Frail, mildly: 8-9 Frail, moderately: 10-11 Frail, severely: 12-17	[53, 86, 87]
Rockwood 7-point Cical Frailty Scale [88]	7- point clinical frailty score derived from the Canadian Study of Health and Ageing (CSHA)	7	0-7	fit 1; Well 2; Well, treated comorbid disease 3; Apparently vulnerable 4; Mildly frail 5; Moderately frail 6; Severely frail 7	[52, 89-91]
VES-13; Vulnerable Elderly Survey [92]	Self-administrated questionnaire concerning perception of health status, example of everyday activity, difficulty performing activities related to health or physical condition	13	0-15	Not frail < 3 Frail ≥ 3	[48, 51, 52, 93]
John Hopkins' Adjusted Clinical Groups (ACG) case-mix system / ACG frailty	Measure of frailty developed to be used specifically on administrative data Assesses frailty by the presence of 11 conditions (e.g., difficulty walking, weight loss, frequent falls,	12	0-12	Not frail 0 Frail ≥ 1	[95-97]

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diagnoses indicator/Johns Hopkins ACG frailty Indicator [94]	malnutrition, impaired vision, decubitus ulcer, incontinence and 4 unnamed criteria.)				
Frailty-based bedside risk analysis index (RAI) [98]	Assessment scoring sex, age, cancer, co-morbidities, residence, cognition, ADL	11	0-75	Not frail < 10 Frail ≥ 10	[99]
Comprehensive geriatric assessment / CGA / Balducci-score [100]	A multidimensional process that identifies medical, psychosocial, and functional limitations of a frail elderly person	4-6	0-4/(6)	Not frail 0 Frail ≥ 1	[52, 101, 102]
Multidimensional Frailty Score [103]	Scoring index based on results of the CGA, patient characteristics and laboratory variables	9	0-15	Not frail ≤ 5 Frail > 5	[103]

Supplementary information. Full literature search.

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('frail elderly'/de OR ((frail* NEAR/6 (elderl* OR centenarian* OR nonagenarian* OR octogenarian* OR septagenarian* OR '65 year*' OR aging OR ageing OR aged OR senior* OR geriatric* OR old OR older))):ab,ti OR ((frail*):ab,ti AND (aged/exp OR aging/de OR 'geriatrics'/de OR 'geriatric care'/de OR 'geriatric assessment'/de))) AND ('abdominal surgery'/exp OR 'breast surgery'/exp OR 'cancer surgery'/exp OR 'ear nose throat surgery'/exp OR 'endocrine surgery'/exp OR 'eye surgery'/exp OR 'head and neck surgery'/exp OR 'major surgery'/exp OR 'neurosurgery'/exp OR 'orthopedic surgery'/exp OR 'plastic surgery'/exp OR 'esophagus surgery'/exp OR 'lung surgery'/exp OR 'transplantation'/de OR 'organ transplantation'/de OR 'kidney transplantation'/de OR 'liver transplantation'/de OR 'lung transplantation'/de OR 'urologic surgery'/exp OR 'vascular surgery'/de OR 'aneurysm surgery'/exp OR 'aorta surgery'/de OR 'artery surgery'/de OR 'carotid artery surgery'/exp OR 'endarterectomy'/exp OR ('artery surgery'/exp NOT 'coronary artery surgery'/exp) OR 'carotid angioplasty'/exp OR 'carotid artery stenting'/exp OR 'blood vessel shunt'/de OR 'leg revascularization'/exp OR 'embolectomy'/exp OR 'endovascular surgery'/exp OR 'limb salvage'/exp OR 'microvascular surgery'/exp OR 'vein surgery'/exp OR (((('non cardiac' OR noncardiac OR abdominal* OR breast* OR cancer* OR ear* OR nose* OR throat* OR endocrine* OR eye* OR head* OR neck* OR orthopedic* OR plastic* OR urologic* OR esophag* OR oesophag* OR lung* OR pulmonar* OR gastrointestin* OR intestin* OR gastric OR vascul* OR joint* OR renal OR kidney OR hepatic OR liver OR pancrea* OR urologic* OR aneurysm* OR aort* OR carotid* OR colorect* OR orthognat* OR breast* OR neoplasm* OR otorhinolar* OR endocrin* OR ophtalmol* OR orthoped* OR plastic* OR urolog*) NEAR/3 (surg* OR operat* OR perioperat*)) OR neurosurg* OR 'general surgery' OR ((organ* OR kidney* OR liver* OR hepatic* OR renal OR pulmonar*) NEAR/3 transplantat*)):ab,ti)

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('Frail Elderly'/ OR ((frail* ADJ6 (elderl* OR centenarian* OR nonagenarian* OR octogenarian* OR septagenarian* OR "65 year*" OR aging OR ageing OR aged OR senior* OR geriatric* OR old OR older))):ab,ti. OR ((frail*):ab,ti. AND (exp aged/ OR exp aging/ OR "Geriatrics"/ OR "Geriatric Assessment"/))) AND (Surgical Procedures, Operative/ OR Specialties, Surgical/ OR Colorectal Surgery/ OR General Surgery/ OR Orthognathic Surgery/ OR breast/su OR exp neoplasms/su OR exp Otorhinolaryngologic Diseases/su OR Endocrine Surgical Procedures/ OR exp Ophthalmologic Surgical Procedures/ OR exp neurosurgery/ OR exp Neurosurgical Procedures/ OR Orthopedics/su OR Surgery, Plastic/ OR exp Pulmonary Surgical Procedures/ OR transplantation/ OR organ transplantation/ OR kidney transplantation/ OR liver transplantation/ OR lung transplantation/ OR exp Urologic Surgical Procedures/ OR Vascular Surgical Procedures/ OR Endarterectomy/ OR embolectomy/ OR limb salvage/ OR Microvascular Decompression Surgery/ OR Neurosurgical Procedures/ OR (((non cardiac OR noncardiac OR abdominal* OR breast* OR cancer* OR ear* OR nose* OR throat* OR endocrine* OR eye* OR head* OR neck* OR orthopedic* OR plastic* OR thora* OR urologic* OR esophag* OR oesophag* OR lung* OR pulmonar* OR gastrointestin* OR intestin* OR gastric OR vascul* OR joint* OR renal OR kidney OR hepatic OR liver OR pancrea* OR urologic* OR aneurysm* OR aort* OR carotid* OR colorect* OR general* OR orthognat* OR breast* OR neoplasm* OR otorhinolar* OR endocrin* OR ophtalmol* OR orthoped* OR plastic* OR urolog*) ADJ3 (surg* OR operat* OR perioperat*)) OR neurosurg* OR ((organ* OR kidney* OR liver* OR hepatic* OR renal OR pulmonar*) ADJ3 transplantat*)):ab,ti.)

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((frail* NEAR/6 (elderl* OR centenarian* OR nonagenarian* OR octogenarian* OR septagenarian* OR '65 year*' OR aging OR ageing OR aged OR senior* OR geriatric* OR old OR older));ab,ti) AND (((('non cardiac' OR noncardiac OR abdominal* OR breast* OR cancer* OR ear* OR nose* OR throat* OR endocrine* OR eye* OR head* OR neck* OR orthopedic* OR plastic* OR urologic* OR esophag* OR oesophag* OR lung* OR pulmonar* OR gastrointestin* OR intestin* OR gastric OR vascul* OR joint* OR renal OR kidney OR hepatic OR liver OR pancrea* OR urologic* OR aneurysm* OR aort* OR carotid* OR colorect* OR orthognat* OR breast* OR neoplasm* OR otorhinolar* OR endocrin* OR ophtalmol* OR orthoped* OR plastic* OR urolog*) NEAR/3 (surg* OR operat* OR perioperat*)) OR neurosurg* OR 'general surgery' OR ((organ* OR kidney* OR liver* OR hepatic* OR renal Or pulmonar*) NEAR/3 transplantat*)):ab,ti)

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TS=(((frail* NEAR/5 (elderl* OR centenarian* OR nonagenarian* OR octogenarian* OR septagenarian* OR "65 year*" OR aging OR ageing OR aged OR senior* OR geriatric* OR old OR older))) AND (((("non cardiac" OR noncardiac OR abdominal* OR breast* OR cancer* OR ear* OR nose* OR throat* OR endocrine* OR eye* OR head* OR neck* OR orthopedic* OR plastic* OR urologic* OR esophag* OR oesophag* OR lung* OR pulmonar* OR gastrointestin* OR intestin* OR gastric OR vascul* OR joint* OR renal OR kidney OR hepatic OR liver OR pancrea* OR urologic* OR aneurysm* OR aort* OR carotid* OR colorect* OR orthognat* OR breast* OR neoplasm* OR otorhinolar* OR endocrin* OR ophtalmol* OR orthoped* OR plastic* OR urolog*) NEAR/2 (surg* OR operat* OR perioperat*)) OR neurosurg* OR "general surgery" OR ((organ* OR kidney* OR liver* OR hepatic* OR renal Or pulmonar*) NEAR/2 transplantat*))))

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("Frail Elderly"[mh] OR ((frail*[tiab] AND (elderl*[tiab] OR centenarian*[tiab] OR nonagenarian*[tiab] OR octogenarian*[tiab] OR septagenarian*[tiab] OR 65 year*[tiab] OR aging OR ageing OR aged OR senior*[tiab] OR geriatric*[tiab] OR old OR older))) OR ((frail*[tiab] AND (aged[mh] OR aging[mh] OR "Geriatrics"[mh] OR "Geriatric Assessment"[mh]))) AND (Surgical Procedures, Operative[mh] OR Specialties, Surgical[mh] OR Colorectal Surgery[mh] OR General Surgery[mh] OR Orthognathic Surgery[mh] OR breast/su[mh] OR neoplasms/su[mh] OR Otorhinolaryngologic Diseases/su[mh] OR Endocrine Surgical Procedures[mh] OR Ophthalmologic Surgical Procedures[mh] OR neurosurgery[mh] OR Neurosurgical Procedures[mh] OR Orthopedics/su[mh] OR Surgery, Plastic[mh] OR Pulmonary Surgical Procedures[mh] OR transplantation[mh] OR organ transplantation[mh] OR kidney transplantation[mh] OR liver transplantation[mh] OR lung transplantation[mh] OR Urologic Surgical Procedures[mh] OR Vascular Surgical Procedures[mh] OR Enderterectomy[mh] OR embolectomy[mh] OR limb salvage[mh] OR Microvascular Decompression Surgery[mh] OR Neurosurgical Procedures[mh] OR (((non cardiac OR noncardiac OR abdominal*[tiab] OR breast*[tiab] OR cancer*[tiab] OR ear[tiab] OR ears[tiab] OR nose*[tiab] OR throat*[tiab] OR endocrine*[tiab] OR eye*[tiab] OR head*[tiab] OR neck*[tiab] OR orthopedic*[tiab] OR plastic*[tiab] OR thoracic[tiab] OR thorax[tiab] OR urologic*[tiab] OR esophag*[tiab] OR oesophag*[tiab] OR lung*[tiab] OR pulmonar*[tiab] OR gastrointestin*[tiab] OR intestin*[tiab] OR gastric OR vascul*[tiab] OR joint*[tiab] OR renal OR kidney OR hepatic OR liver OR pancreas*[tiab] OR pancrea*[tiab] OR urologic*[tiab] OR aneurysm*[tiab] OR aort*[tiab] OR carotid*[tiab] OR colorect*[tiab] OR general*[tiab] OR orthognat*[tiab] OR breast*[tiab] OR neoplasm*[tiab] OR otorhinolar*[tiab] OR endocrin*[tiab] OR ophtalmol*[tiab] OR orthoped*[tiab] OR plastic*[tiab] OR urolog*[tiab]) AND (surg*[tiab] OR operation[tiab] OR operative[tiab] OR perioperat*[tiab])) OR neurosurg*[tiab] OR ((organ[tiab] OR organs[tiab] OR kidney*[tiab] OR liver*[tiab] OR hepatic*[tiab] OR renal Or pulmonar*[tiab]) AND transplantat*[tiab]))) AND publisher[sb]

Google scholar

200 first results: Frail|frailty elderly|older|seniors "non cardiac surgery"|noncardiac surgery"
All results: allintitle:Frail|frailty elderly|older|seniors surgery|operative -cardiac

Supplementary Table 2. Quality assessment of included studies.

Study	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Confounding measurement and account	Analysis	Overall rating
Abt	+	+	+	+	±	+	11
Adams	+	+	+	+	±	+	11
Arya	+	+	+	+	+	+	12
Augustin	+	+	+	+	+	+	12
Brahmbhatt	+	+	+	+	+	+	12
Bras	±	±	+	+	?	±	8

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Chappidi	+	+	+	+	+	+	12
Chimukangara	±	+	+	+	±	±	9
Cloney	+	±	+	+	-	±	8
Cooper	+	+	+	±	-	±	8
Courtney-Brooks	±	+	+	+	-	±	8
Dale	±	+	±	+	±	±	8
Dasgupta	±	±	+	+	+	+	10
Farhat	+	+	±	+	?	+	9
Flexman	+	+	+	+	+	±	11
Hewitt	±	+	+	+	±	±	9
Huisman	+	±	+	+	+	+	11
Joseph	±	±	+	+	±	+	9
Kenig	±	±	+	±	+	+	9
Kim (2016)	+	+	+	±	+	+	11
Kim (2014)	+	±	+	+	+	+	11
Krishnan	±	±	±	±	-	±	6
Kristjansson	+	+	+	+	+	±	11
Kua	±	?	+	+	±	+	8
Lascano	+	+	+	+	+	+	12
Lasithiotakis	±	?	±	+	-	±	5
Leung	-	±	+	±	+	+	8
Levy	+	+	+	+	+	+	12
Li	+	±	±	+	+	±	9
Louwers	+	+	+	+	±	+	11
Makary	+	+	+	+	±	+	11
McAdams-DeMarco	±	+	+	+	+	±	10
McIsaac (JAMA)	+	+	+	+	+	+	12
McIsaac	+	+	+	+	+	+	12
Melin	+	+	+	+	-	-	8
Mogal	+	+	+	+	+	+	12
Mosquera	+	+	±	+	?	+	9
Neuman	+	±	±	+	±	+	9
Obeid	+	+	+	+	±	±	10
Partridge	±	±	+	+	±	+	9
Pearl	+	+	+	+	±	+	11
Phan	+	+	+	+	+	+	12
Reisinger	+	+	+	+	±	+	11
Revenig (2015)	+	+	+	+	±	±	10
Revenig (2014)	±	+	+	+	±	+	10
Revenig (2013)	±	+	+	+	+	+	11

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Robinson	+	+	±	+	-	±	8
Shin (2017)	+	+	+	+	+	+	12
Shin (2016)	+	+	+	+	+	+	12
Suskind	+	+	+	+	+	+	12
Suskind (Urology)	+	+	+	+	+	+	12
Tan	±	+	+	+	±	+	10
Tegels	±	±	+	+	±	+	9
Tsiouris	+	+	+	+	±	+	11
Ugolini	±	±	+	+	±	-	7
Uppal	+	+	+	+	+	+	12

Study participation: The study correctly defines and describes the study population

Study attrition: The study was able to obtain a complete follow up

Prognostic factor management: The study provides a clear description of the prognostic factor measured

Outcome measurement: The study provides a clear definition of outcome

Confounding measurement and account: Adequately valid and reliable measurement of potential confounders

Analysis: The statistical analysis is appropriate for the design of the study

Description of used symbols:

+ Yes; adequate and complete description

± Partly; incomplete description

? Unsure; doubtful description

- No; not described