Draft for consultation



Screening in old age to prevent hospitalization and death

A draft report for the UK National Screening Committee

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Introduction

- The purpose of this review is to appraise screening in old age, to prevent hospitalization and early death, against the UK National Screening Committee (UKNSC) criteria for the viability, effectiveness and appropriateness of a screening programme (UKNSC 2003).
- 2. The current UKNSC policy on screening in the elderly, developed in 2006, states that systematic screening in old age is not recommended.
- 3. Evidence supporting this policy was drawn from a cluster-randomised factorial trial by Fletcher et al published in 2004ⁱ. In this study, older people aged at least 75 were randomized to either universal assessment or to targeted assessment in which only those with three or more problems identified during a baseline 25-item questionnaire were assessed. The researchers considered the universal assessment arm of the trial to be equivalent to the annual assessment required by the general practice contract in place at that time¹ and therefore viewed the group randomized to this arm of the trial as the control group. Both groups in the trial were also subsequently randomized to management by either a geriatric team or primary care team. Measured outcomes included mortality, hospital and institutional admissions, and quality of life. The study results reported no significant differences in outcomes between universal and targeted assessment groups or between geriatric and primary care management.
- 4. The current review is based on a literature search conducted by the UKNSC in June 2012, for which the search strategy is detailed in Appendix 1. Because the existing UKNSC policy was based on evidence published in 2004, the search date for the literature review was from 2004 onwards. In line with the age cut off for assessment used in the Fletcher study and the GP contract, the literature search focused on studies of people aged 75 or more living in the community. However, evidence from studies of populations that include people younger than 75 years has also been included where relevant and identified in the literature search. Evidence relating only to residents of nursing homes or other such institutions is not considered, because it would not be generalizable to population-based screening. The following topics are also outside the scope of this review: prevention of falls in the elderly, assessment and/or management of hospitalized patients; prevention of cognitive or functional impairment and/or disability in the elderly.
- 5. The NSC criteria were drawn up for the assessment of screening programmes in which a single test is used to screen for a single condition which, on identification, is treated according to a specific and focused intervention. Whilst this is the case for most screening programmes in the NHS, the position for screening in old age to prevent hospitalization and early deaths is different. The admission to hospital of an elderly person has many possible causes and is often multi-factorial and the treatment of conditions in later life is often complex, particularly given the presence of co-morbidities. Hence the direct application of the NSC criteria to this appraisal of evidence is far from straightforward.

¹ In 1990, the UK Department of Health introduced a contract of service for general practitioners (GPs) requiring them to offer an annual multi-dimensional assessment to patients aged 75 years and older [Department of Health. Terms of service for doctors in general practice. London: HM Stationery Office, 1989]. The current General Medical Services (GMS) contract (commonly referred to as the GP contract), introduced in 2004, specifies that, for patients aged 75 years and over who request a consultation and who have not had one in the previous 12 months, the GP should investigate and examine the patient as appropriate (or, in the words of the GMS contract: 'make such inquiries and undertake such examinations as appear to it to be appropriate in all the circumstances').

The Condition

The condition should be an important health problem

6. The aim of systematic population screening in old age would be to prevent elderly people from experiencing adverse health outcomes leading to hospital admission and/or early death. For the purposes of appraising the potential screening programme against this criterion, the 'condition' will be taken to mean the outcomes of hospital admission and/or death earlier than would be expected from prevailing life expectancy figures.

Hospital admissions in the elderly

- 7. There is no doubt that hospital admissions in the elderly are an important health problem. In 2010/11, there were 17.3 million hospital episodes (finished consultant episodes (FCEs)) in England, of which just over one third involved emergency admission. In the same year, four million hospital episodes, almost a quarter of all episodes, involved people aged 75 years and over with the average length of stay almost twice that for all age groups combined (10.5 days compared with 5.5 days). In contrast, this age group represents less than 8% of the total population of Englandⁱⁱ.
- 8. The number of hospital admissions involving elderly people has grown at a much faster rate over the last ten years than that for any other age group. The number of hospital admissions in England for people aged 75 and over increased by 65% between 2000/01 and 2010/11 compared to the overall growth rate of 41%; the number of hospital admissions for 60 to 74-year-olds also increased rapidly over the same period.^{III}
- 9. Therefore, as the data shows, hospital admissions in the elderly are on the increase, a disproportionate number of admissions occur in the elderly compared with other age groups, and lengths of stay are longer than average.

Deaths in the elderly

- 10. The Office for National Statistics (ONS)^{iv} publish data on 'avoidable mortality' which relates to causes of death that are considered avoidable in the presence of timely and effective healthcare or public health interventions. The definition of avoidable mortality includes both *preventable deaths*² which could be avoided by public health interventions and *amenable deaths*³ which could be avoided through good quality health care. The list of identified causes of avoidable mortality covers 12 different categories of conditions and includes leading causes of death in the UK such as cardiovascular disease, cancers and respiratory disease. Most of the conditions on the list have a specified age range of 0 to 74 years so that only deaths occurring within this age range are counted.
- 11. In 2010, there were 493,242 deaths registered in England and Wales. Two-thirds (66.7%) of all deaths occurred in people aged 75 and over, with fewer deaths in men

² Preventable mortality: A death is preventable if, in the light of understanding of the determinants of health at the time of death, all or most deaths from that cause (subject to age limits if appropriate) could be avoided by public health interventions in the broadest sense.

³ Amenable mortality: A death is amenable if, in the light of medical knowledge and technology at the time of death, all or most deaths from that cause (subject to age limits if appropriate) could be avoided through good quality healthcare.

(139,875) than in women (189,301); 58.8% of deaths in men were in the 75 and over age group compared with almost three-quarters (74.1%) of deaths in women. As to be expected, a lower proportion of deaths occurred in people under 75 years. Almost a third (32%) of deaths in men occurred in those aged 65 to 74 years and a fifth (19.7%) were in those aged 75 to 84 years; corresponding figures for women were 28.2% and 12.8%.^v

12. The ONS figures show that, in the same year, the number of deaths due to causes considered avoidable was 117,137 (71,042 in males, 46,095 in females), representing almost a quarter (23.7%) of all deaths registered in England and Wales. If it is assumed that the age distribution of avoidable deaths amongst males and females is similar to the age distribution of all deaths registered in England and Wales, then the number of avoidable deaths occurring in people aged 70 to 74 years in 2010 would have been almost 10,000. Applying these figures to the 75 to 79 year age group would give a figure of more than 15,000 deaths, equivalent to around 3,000 deaths for each single year within the age range 75 to 79 years.

Life expectancy

- 13. Another approach to assessing the need for systematic screening in old age in terms of the size of the problem being addressed, would be to look at levels of healthy life expectancy (an estimate of expected years of life spent in self-reported good health) or disability-free life expectancy (an estimate of expected years of life spent without a self-reported limiting long-standing illness or disability) in the elderly.
- 14. Healthy life expectancy (HLE)⁴ and disability-free life expectancy (DFLE) at a given age for an area in a given time period for a specified population, such as England, is an estimate of the average number of years a person would live in very good or good general health or without a limiting chronic illness or disability if he/she experienced the specified population's particular age-specific mortality and health status rates for that time period throughout the rest of his/her life.
- 15. Taking the first of these, life expectancy (LE) at age 65 in the UK increased in each three-year period between 2004-06 and 2008-10, from 17.0 to 18.0 years for men and from 19.8 to 20.6 years for women. HLE for males at age 65 in the UK was 10.1 years; equivalent to 56.8 per cent of their remaining lives. By contrast females in the UK at age 65 could expect to live for a further 11.6 years in very good or good general health; also equivalent to 56.8 per cent of their remaining lives. In 2008-10, males at age 65 in the UK could expect to live 10.4 years free from a limiting chronic illness or disability (DFLE); equivalent to 58.3% of their remaining lives. For females, DFLE at age 65 was 11.2 years; equivalent to 54.6% of their remaining lives free from a limiting persistent illness or disability.^{vi}
- 16. The figures for LE, HLE and DFLE for men and women at age 65 suggest that there is some scope for improving the proportion of years beyond the age of 65 which are free from chronic illness or disability. The age at which limiting chronic illness or disability appears to become a problem is 75 years in men and 76 years in women.
- 17. In summary, hospital admissions and avoidable deaths in the elderly are important health problems. There is also scope for improving the proportion of years beyond

⁴ While life expectancy (LE) provides an estimate of average expected life-span, healthy life expectancy (HLE) divides total LE into years spent in good or 'not good' health; disability-free life expectancy (DFLE) divides LE into years lived with and without a chronic illness or disability. These figures are three-year averages. LE is taken from the UK national interim life tables published annually by ONS, and the measures of health and chronic illness from the General Household Survey (GHS) in Great Britain and the Continuous Household Survey (CHS) in Northern Ireland.

the age of 65 which are free from chronic illness or disability. This criterion is therefore met.

The epidemiology and natural history of the condition, including development from latent to declared disease, should be adequately understood and there should be a detectable risk factor, disease marker, latent period or early symptomatic stage

18. If the aim of systematic screening in old age is to reduce the risk of hospital admission or death in the short to medium term, the risk factors for these adverse outcomes need to be adequately understood and there needs to be a detectable risk factor/s or stage prior to hospital admission and/or death.

Hospital admissions

- 19. There are many possible reasons for admission to hospital of an elderly person. A key factor determining admission will be the person's underlying clinical condition which, in the case of an elderly person, may involve multiple morbidities. Other factors, however, such as a person's age, their socio-economic status and living arrangements, will also play a part in the decision to admit them to hospital.
- 20. The likelihood of hospital admission will also depend on supply side factors such as the type, range and capacity of local health services and, specifically, the availability of alternatives to hospital admission for the elderly such as community hospitals, integrated (multidisciplinary health and social care) community teams, and virtual wards. Thus, admission of an elderly person to hospital represents only one of a number of possible options in the care pathway for that individual.
- 21. It is therefore unlikely that a single risk factor or early symptomatic phase can be used in a screening programme in old age to identify individuals likely to benefit from interventions aimed at improving their health outcomes. Instead, the multifactorial nature of hospital admissions, particularly in the elderly, is likely to involve the identification of a combination of risk factors for hospital admission.

Avoidable deaths

- 22. The main causes of death in men in England and Wales, as shown in Appendix 2, are ischaemic heart disease (IHD), cerebrovascular disease (strokes), and cancers of the respiratory tract. In women, dementia replaces cancers of the respiratory tract as the third main cause of death.^{vii}
- 23. In 2001, deaths due to causes considered avoidable represented approximately 26% of all deaths registered in England and Wales. This proportion decreased slightly over the period between 2001 and 2010 with avoidable deaths accounting for almost 24% of all deaths in 2010. The condition making the largest contribution to avoidable mortality was IHD which caused a total of 21,800 deaths in 2010, a rate of 34.2 per 100,000 population. Considering males and females separately, IHD was the main avoidable cause of death for males; avoidable neoplasm of trachea, bronchus and lung was the main cause of female avoidable mortality.^{viii}
- 24. Screening or other programmes aimed at preventing or reducing the adverse health consequences of these specific conditions might therefore be expected to have a greater impact on reducing deaths than universal screening in the elderly.

Decline in health status associated with ageing

- 25. Another approach to appraising this screening programme against this criterion would be to look at decline in health status associated with ageing and its relationship with adverse health outcomes.
- 26. One such approach involves the concept of 'frailty' which is a commonly used term used to describe older people at increased risk of adverse outcomes such as onset of disability, morbidity, hospitalization, institutionalization and/or mortality. Many definitions of frailty have been proposed over the years, ranging from a narrow definition involving physical phenotype (for example, shrinking, weakness, poor endurance, slowness, low activity) to much broader definitions which, in addition to physical factors, also include cognitive, functional and social factors. Pre-frail and frail states have been described, as has the idea that a person can move between frail and non-frail states in either direction. Numerous studies, such as that by Woods et al^{ix}, have reported an association between frailty and adverse health outcomes. However, there is no commonly used definition of frailty or of the criteria used to identify frailty. This is clearly illustrated in the results of a study by van lersel et al^x which reported that the prevalence of frailty in a sample of 125 elderly people ranged from 33% to 88% depending on the frailty definition, and hence evaluation tool, used. In the absence of a common definition for frailty, it cannot be used in a screening programme for the purposes of identifying people at risk of adverse outcomes.
- 27. Another approach to looking at declining health status with age is to assess levels of functional impairment or disability in terms of a person's difficulty in performing the basic everyday tasks needed for independent living. These tasks are commonly referred to as activities of daily living (ADLs). Researchers have demonstrated a relationship between mortality and functional impairment in which mortality increases with the level of ADL limitation. A recent example of this is a study by Stineman et al^{xi} of 9,272 community-dwelling men and women aged 70 or over, which demonstrated that those with no ADL limitations had a longer life expectancy than those with less severe ADL limitations and that the ability of the ADL limitation to predict mortality was greatest during the first year of follow up. Despite this finding, the relationship between functional impairment and mortality is not well understood so does not meet this criterion for introduction of a screening programme in old age.
- 28. On the basis of the evidence presented here, it is fair to say that the risk factors for hospital admission and death in the elderly are complex and not well understood and there is no clearly identifiable stage prior to development of the adverse outcomes which can be detected. The criterion is not met.

All the cost-effective primary prevention interventions should have been implemented as far as practicable

- 29. Cost-effective primary prevention interventions in the elderly which will help to reduce hospital admission rates and early deaths include primary prevention of cardiovascular disease, cancer screening, influenza immunization, and prevention of falls/osteoporosis.
- 30. Some primary prevention measures are being implemented widely. For example, in the provision of smoking cessation advice to at risk groups, the average general practice score for Quality Outcome Framework (QOF) indicators in England was almost 93%⁵ in 2010/11. For other interventions, there is scope for improvement;

⁵ The percentage of the maximum QOF score available

for example, breast cancer screening uptake amongst women in England was 76.9% in 2010 and cervical screening uptake was 75.5%.^{xii}

- 31. Influenza vaccine uptake amongst people aged 65 and over in England was 74% at the end of the 2011/12 winter season (cumulative data covering seasonal flu vaccine administered from 1 September 2011 to end of 31 January 2012) falling just short of the WHO target of 75%.^{xiii} Evidence from national health and lifestyle surveys also suggests that there is scope for improving levels of physical activity and healthy eating amongst the elderly. For example, in 2008, the proportion of men and women in Great Britain who reached the recommended physical activity levels in place at the time declined with age such that only 10 % of men and 6% of women attained the target at age 75 and above.^{xiv}
- 32. Based on the evidence presented here, this criterion is not met.

If the carriers of a mutation are identified as a result of screening the natural history of people with this status should be understood, including the psychological implications.

33. Not relevant to screening in old age.

The Test

There should be a simple, safe, precise and validated screening test

- 34. In order to meet this criterion, there needs to be a simple, safe, precise and validated screening test which identifies elderly people at risk of hospital admission and/or death in the short to medium term. For the purposes of this review, short to medium term is considered to be within 24 months of the test being undertaken.
- 35. Comprehensive geriatric assessment (CGA) refers to the systematic assessment of an elderly person for the purposes of identifying health problems amenable to healthcare interventions and improving health outcomes. It involves detailed assessment of an older person's functional status, cognition, psychological status, social support, nutritional status, co-morbidity and medications. It is usually conducted by an individual or team of healthcare professionals, and is time-consuming and costly. A lot of research has therefore focused on the development of a simple screening tool which can be used to identify elderly people at risk of adverse health outcomes and for whom more detailed assessment is indicated. Since this review is focused on the appraisal of a screening programme which aims to prevent hospital admissions and deaths in the elderly, any evidence relating to investigative tools which identify people at risk of hospital admission and/or death in the short to medium term was considered relevant. Tools aimed at identifying an individual's risk of other outcomes such as falls, functional impairment/disability and/or cognitive decline are outside the scope of this review.
- 36. The different tools available for identifying older people at risk of hospital admission and/or death can be grouped as follows:
 - tools which assess an individual's frailty (or aspects thereof) or health status.
 These involve either self-reporting and/or measurement by a healthcare worker and may cover multiple health issues or 'items' or a single issue such as physical or functional limitations.

- tools which attempt to predict the risk of hospital admission (or re-admission) via modelling techniques using demographic and/or health service utilization data relating to the population under investigation.
- 37. The different tools are considered in more detail below.

Frailty assessment tools

- 38. A large number of assessment tools have been developed to identify frailty in elderly people. In the absence of a consensus definition for frailty, the coverage of these assessment tools varies, with some focusing only on physical aspects of frailty whereas others have a much broader remit including cognitive, functional and social in addition to physical aspects of frailty.
- 39. This review identified five systematic reviews of frailty instruments, most of which only described characteristics of different tools used to screen for frailty but did not include any information on validation of the identified tools.
- 40. A systematic review, by Pialoux et al^{xv}, investigated the development and/or evaluation of frailty instruments for use in primary care but did not provide information on whether or not any of them could be used to identify risk of hospitalization and/or mortality. All except one of the 10 frailty tools identified by Pialoux involved a self-administered questionnaire, the number of items covered ranging from 6 to 49. Most of the tools were evaluated against comprehensive geriatric assessment (CGA) by a geriatrician; a small number were evaluated using other geriatric assessment tools which had themselves been validated against the CGA. One tool was evaluated in the over 50s, nine tools were evaluated in people over 62 years, and four were evaluated in the over 75s. Study populations for nine of the studies ranged from 48 to 842 with one large study recruiting 31,115 people. The overall quality of the studies was poor according to the Terwee scale^{xvi}, with only the construct validity reported in most studies. Amongst the six frailty tools for which sensitivity and specificity compared to CGA were reported, sensitivity ranged from 0.65 to 0.95, specificity from 0.50 to 0.95. Two of the tools were identified by the authors as a potentially suitable screening tool for the identification of frailty in primary care - the Tilburg Frailty Indicator (TFI) and the SHARE-FI.
- 41. The TFI gave the best results for psychometric properties amongst all the instruments investigated. It covered four of five frailty domains recommended by the European, Canadian and American Geriatric Advisory Panel (GAP) and was validated against CGA in a primary care setting; its main disadvantage is that it is relatively long to administer (14 minutes). Further evidence on the TFI was provided in a single study by Daniels^{xvii}, published in 2012, in which the tool was compared with two other tools - the Groningen Frailty Indicator (GFI), and the Sherbrooke Postal Questionnaire (SPQ) - in their ability to predict hospital admission, mortality and disability in 430 community-dwelling people aged 70 or over. Values for the area under the receiver operator curve (AUC) for all three instruments at the proposed cut off points for all three dependent variables (development of disability, mortality, and hospital admission) were reported to lie between 0.54 and 0.67⁶. For all three tools, sensitivity for predicting mortality within one year was around 70%, with specificity between 41% and 61%. For hospital admission, SPQ scored the highest for sensitivity (76%), compared with GFI (52%) and TFI (53%); whereas specificity was lowest for SPQ (44%) compared with GFI (55%) and TFI (65%).

⁶ The perfect test would have an AUC of 1, whereas a test with no diagnostic capability would have an AUC of 0.5.

- 42. The second tool classed as very promising by Pialoux et al was the SHARE-FI. The tool classifies subjects into one of three categories non-frail, pre-frail or frail, covers 4 of 5 domains required by GAP and is easy to use in primary care. However, it has not been validated against geriatric assessment, was validated amongst a population aged 50 plus and requires a dynamometer for strength of grip, an instrument not commonly available in a GP practice. Results from the validation study by Romero-Ortuno^{xix} showed that the odds ratios for mortality in women were 2.1 for the "pre-frail" and 4.8 for the "frail" group compared with the "non-frail" group; in men, the odds ratios were 3.0 and 6.9 respectively. The mean duration of follow up was 2.4 years; mortality data was only available for around two-thirds of study participants.
- 43. Another tool developed in the UK by Lyon et al is the EARLI (Emergency Admission Risk Likelihood Index), a simple six-item tool with questions about heart problems, leg ulcers, mobility, memory, recent hospitalization and general health status. The instrument was developed in a pilot study and then validated in 3,032 general practice patients aged 75 or older. At a cut-off score of 6, the tool was reported to have a high negative predictive value (85%) for emergency admission within the next 12 months, with sensitivity and specificity both 64%.
- 44. The performance of the different tools described here is summarized in Table 1. Since none of the tools achieves high sensitivity and/or specificity, they are not suitable for use in a population screening programme.

Reference	Tool	Outcome*	Performance of tool**					
			Sens	Spec	PPV	NPV	AUC	OR (age- adjusted)
Lyon ^{xviii}	EARLI	Emergency department admission	64%	64%	35%	85%	-	-
Romero- Ortuno ^{xix}	SHARE- FI	Mortality (mean follow up 2.4 yrs)		-	-	-	-	Women 2.1 - 4.8 Men 3.0 - 6.9
Daniels ^{xx}	SPQ	Hospital admission	76%	44%	22%	90%	60%	2.42
		Mortality	71%	41%	3%	98%	56%	0.92
	TFI	Hospital admission	53%	65%	24%	87%	60%	2.59
		Mortality	67%	61%	5%	98%	64%	1.05
	GFI	Hospital admission	52%	55%	20%	84%	54%	1.33
		Mortality	73%	54%	4%	98%	64%	1.35

Table 1: Performance of different tools used to detect frailty/health status

*all outcomes refer to last 12 months unless otherwise specified

** Shorthand used for performance measures: Sens = Sensitivity; Spec = Specificity; PPV = Positive Predictive Value; AUC = Area under the Curve; OR = Odds Ratio.

Tools to assess functional limitations/physical frailty

45. Functional limitations are usually assessed via tests of physical performance in which an individual is asked to undertake a specific task (or tasks) and is evaluated in an objective, standardized way using predetermined criteria. The Short Physical Performance Battery (SPPB) is one of the most widely used and validated assessment tools.^{xxi} It measures lower extremity functional limitations and includes timed tests of standing balance, walking speed, and repeated chair stands. The SPPB usually takes less than 10 minutes to complete, is freely available and is portable, allowing it to be completed in a person's home or in a clinic. The SPPB was validated in the Established Population for Epidemiologic Studies of the Elderly

(EPESE), a cohort of 1,122 community-dwelling non-disabled adults, aged 70 and over. On the basis of this study, the SPPB predicted functional decline, mortality and hospitalization over a period of four years.^{xxii} xxiii The test–retest reliability of the SPPB and each of its components was high.^{xxiv} Similarly, the EPIDOS study in 7,250 community-dwelling women aged 75 or over, concluded that low SPPB, low grip strength and slow walking speed were all significantly associated with death during a mean follow up period of 3.8 years.^{xxv}

- 46. Gait speed, also referred to as *walking speed*, has been shown in individual cohort studies to be associated with adverse outcomes. For example, Cesari et al^{xxvi} found that, in a US study of 3,047 community-dwelling adults, mean age 74.2 years, those with a walking speed of less than 1 m/s presented a significantly higher risk of death, hospitalization and persistent lower extremity limitation during one year of follow up. More recently, a pooled analysis by Studenski et al^{xxvii} of nine cohort studies showed that gait speed was associated with differences in the probability of survival at all ages in both sexes, but was particularly informative after the age of 75 years. In men, for example, the probability of 5-year survival at age 85 ranged from 0.30 to 0.88 and the probability of 10-year survival at age 75 ranged from 0.18 to 0.86. In an earlier study involving 487 adults aged 65 and older, Studenski demonstrated an association between gait speed and future hospitalization, with an odds ratio for hospital admission of 0.62 for every 0.2m/s increase in gait speed.^{xxviii} Gait speed can be assessed by non-professional staff with a stopwatch in a 4-metre corridor, so is a relatively simple measure to perform.
- 47. Whilst these tools show some promise in terms of their potential to predict risk of hospitalization and/or death, further evaluation studies are required before they can be recommended for routine use.

Threshold modelling and predictive modelling techniques

- 48. A number of different modelling techniques have been used to predict the future risk of hospital admission in individual patients. These include threshold modelling and predictive modelling. Threshold modelling, identifies patients who meet a specified criterion or threshold for a parameter of interest, such as hospital admission or readmission. This approach was used in the UK in some of the Evercare pilot sites where the threshold used for case-finding was the patient's age (over 65 years) and a history of two or more emergency admissions in the previous year. Threshold modelling techniques have the disadvantage of being subject to selection bias and regression towards the mean such that high rates of previous admissions alone do not necessarily mean that an individual has an ongoing high risk of future admissions. This was illustrated by Roland et al in their analysis of hospital episode statistics for the period 1997-8 to 2002-3.xix For patients who had two or more admissions in the baseline year, the analysis showed a 75% reduction in admissions (from 2.6 to 0.6 admissions per year) in the following year. In line with this finding, an independent evaluation of the Evercare scheme showed no reduction in unplanned admissions following the intervention over and above the fall in admissions which would be expected due to regression to the mean.xxx
- 49. Predictive modelling aims to establish associations between different sets of variables in order to predict future outcomes. There are many predictive modelling techniques, most of which use regression models, but the evidence for which is the most effective is lacking. Table 2 shows predictive modelling tools that have been used in the UK together with the datasets used to create the tool, the outcomes predicted and the tool's performance in terms of its ability to identify patients at high risk of hospital admission. Overall, the performance of the predictive modelling tools in predicting hospital admission during the short to medium term is reasonably good.

However, there is no evidence that the tools are helpful in reducing emergency hospital admissions in the short to medium term through targeted interventions.

Model	Population	Data used to create model	Outcome/s predicted	Performance data where
				found
Patients At Risk of Re- hospitalization Case Finding Tool (PARR, PARR+ and PARR++)	65+ with previous hospital admission in previous 3yrs.	Sample of HES data plus variables from national census	Risk of hospital re-admission in next 12 months	Sensitivity 54%, Specificity 72%, PPV 65% at risk threshold of 50; Sensitivity 8%, Specificity 99%, PPV 84% at risk threshold of 80.
Combined Predictive Model (CPM) developed from PARR model	GP-registered population	Hospital admission data (from SUS) and GP (Read code) data	Risk of unplanned hospital admission in next 12 months	In the highest risk segments, CPM improves predictive performance over PARR++ ^{xxxi}
Scottish Patients at Risk of Readmission and Admission (SPARRA, SPARRA V2, SPARRA V3)	SPARRA: People >65 yrs with hospital admission in previous 3 years. SPARRA V2: all ages. SPARRA V3: 75+, 15-64 with LTCs, 'younger emergency dept'.	SPARRA: Hospital admission and demographic data. SPARRA V3 included wider range of data e.g. outpatient and prescription.	Risk of emergency hospital admission in next 12 months	SPARRA V3: PPV 60%, sensitivity 11% at risk threshold of 50%.
Sussex Predictor of Key Events (SPOKE)	Whole population	Hospital admissions, outpatients and community clinics, age and code	Risk of emergency hospital admission for chronic illness in next 12 months	Reported to be equivalent to national risk prediction models
Predictive Risk Stratification Model (PRISM) developed by Health Solutions Wales	GP-registered population	Hospital data and GP data	Risk of emergency hospital admission	-
United Health Risk Information System for Cost (RISC)		Multiple data sources including census, primary and secondary care	Risk of unplanned hospital admission in next 12 months	-
University of Dundee Predicting Emergency Admissions over the Next Year (PEONY) Tool	Population aged 40 plus registered with GP.	Demography, history of hospital admissions & prescriptions in previous 3 years	Risk of first emergency hospital admission	PPV 17% to 67% depending on risk threshold used.

Table 2: Characteristics of predictive models used in the UK to identify risk of hospita
admission (or re-admission) in the elderly

50. In summary, there are a number of different tools which have been developed to identify risk of hospital admission and/or death. However, none of them meet all of the characteristics required for a test to be suitable for routine use in a population screening programme.

The distribution of test values in the target population should be known and a suitable cut-off level defined and agreed

51. In the previous section, no tests were deemed suitable for screening in old age to prevent hospital admissions and/or early deaths. In the absence of a suitable test, the distribution of test values in the target population cannot be known and a suitable cut-off level cannot be defined. The criterion is not met.

The test should be acceptable to the population

52. This review has not identified any tests suitable for screening in old age to prevent hospital admissions and/or early deaths. There is therefore no evidence that can be presented here to enable appraisal against this criterion.

There should be an agreed policy on the further diagnostic investigation of individuals with a positive test result and on the choices available to those individuals

53. It is common practice for older people deemed at higher risk of adverse outcomes to be offered comprehensive geriatric assessment in order to identify any problems which are amenable to health care (or other) interventions. However, there is no agreed policy on the investigation of or on the choices available to those individuals. The criterion is not met.

If the test is for mutations the criteria used to select the subset of mutations to be covered by screening, if all possible mutations are not being tested, should be clearly set out

54. Not relevant to screening in old age.

The Treatment

There should be an effective treatment or intervention for patients identified through early detection, with evidence of early treatment leading to better outcomes than late treatment

55. The literature search identified four systematic reviews, published since 2004, which included studies of interventions in elderly people living in the community and identified as 'frail' or at 'high risk' of adverse outcomes. All of these systematic reviews investigated geriatric assessment with or without further intervention and included hospital admission and/or mortality as outcome measures. Details of the systematic reviews are summarised in Table 3.

- 56. Their results show a mixed picture. The review by Hsu-Ko Kuo et al reported no survival benefit for community-based comprehensive geriatric assessment (CGA) compared with usual care in frail elderly people at risk of functional decline. The review by McCusker et al reported that most interventions conducted in community settings reduced emergency department utilisation in high risk older people but the results were not quantified and the review did not investigate hospital admissions as an outcome. The third review by Beswick et al reported that geriatric assessment in elderly people identified as frail led to reduced hospital admissions compared with usual care but had no effect on mortality. The review by Huss et al reported that preventive home visiting programmes reduce the risk of death in younger people (less than 77 years) but not in older people. However, the review included both studies of unselected populations, as well as those involving people with various impairments, and results were not reported separately for this second group.
- 57. Although the literature search for this report focused on literature published since January 2003, two earlier systematic reviews were identified during review of the literature. The first of these, by Stuck et al^{xxxii} (1993), investigated 28 controlled trials of comprehensive geriatric assessment (CGA) in older people in a variety of settings. Meta-analysis of results from the 14 studies investigating CGA in community settings showed a reduction in mortality risk at 36 months (odds ratio 0.86; 95%CI 0.75 to 0.99); CGA conducted in an institutional setting was also associated with reduced mortality risk at 6 and 12 months. Meta-analysis of all CGA programmes together showed a reduction in risk of hospital (re-)admission compared with no intervention (odds ratio 0.88; 95%CI 0.79 to 0.98). The second review by Elkan et al^{xxxiii} (2001) included 15 controlled studies of home visiting in older people. Meta-analysis of 8 studies in the general elderly population showed that home visiting was associated with reduced mortality (odds ratio 0.76: 95%CI 0.64 to 0.89); a similar reduction in mortality was reported from meta-analysis of four RCTs in frail elderly populations. Conversely, amongst the nine studies with hospital admission as an outcome, home visiting was not found to be associated with a reduced risk of hospital admission.
- 58. The literature search also identified four RCTs published more recently than the search date of the systematic reviews and which investigated interventions in elderly people living in the community and identified as 'frail' or at 'high risk' of adverse outcomes including hospital admission and/or death. The RCTs are summarised in Table 4. Only one RCT, by Monteserin et al, reported a difference between intervention and control groups. In this study, targeted intervention by a geriatrician (on a one to one basis for people identified as frail or in a group setting for all others) reduced their combined risk of death or admission to a nursing home or home care programme compared with usual care. The study did not include risk of hospital admission as an outcome. The other three RCTs reported no significant difference between intervention and comparator groups.
- 59. In addition to the four published RCTs, a further RCT was identified, the methodology of which was described in an article by Metzelthin et al^{xxxiv}. This cluster-randomised trial, conducted in The Netherlands, involved the use of a postal screening questionnaire, the Groningen Frailty Indicator, to identify frail elderly who were then randomised to multi-disciplinary primary care or usual care. Measured outcomes included mortality, healthcare utilisation and costs. The study was completed in June 2012 but its results were not available at the time of publication of this report.
- 60. No randomised controlled trial evidence was found relating to other interventions which have been used in older people deemed at high risk of adverse outcomes, such as case management, community matrons and virtual wards.

Refer-	Studies	Population	Intervention	Comparator	Follow	Outcomes	Results	Comments
ence Hsu-Ko Kuo ^{xxxv} 2004	9 RCTs	3750 'frail' older people 'at risk for functional decline' (mean age 71 to 79)	Community-based ('outpatient') comprehensive geriatric assessment (CGA)	Usual care	up 12 to 24 mnths	Survival	No survival benefit for community-based CGA compared with usual care.	
McCusk -er ^{xxxii} 2006	26 studies (16 RCTs)	Approx. 10,000 older people, mostly 'high risk', aged 65+	Range of 'geriatric interventions' including geriatric assessment or management, and case management. Wide range of settings including OP and primary care.	Not specified	6 mnths to 64 wks	Emergency department (ED) utilisation	Most interventions conducted in OP or home care settings were successful in reducing ED utilisation.	Results presented descript- ively. No meta- analyses
Beswick ^{xxxvii} 2008	89 RCTs	Approx. 98,000 older people living at home, mean age ≥65. In 24 RCTs, elderly were 'frail'.	Range of interventions including geriatric assessment.	Not specified.	≥6 mnths	Living at home, death, nursing home & hospital admission, falls, physical function.	Geriatric assessment in elderly people selected as frail reduced hospital admission compared with controls [RR 0.90 (95%Cl 0.84 to 0.98)]; there was no significant effect on mortality.	16 RCTs of frail elderly (n=6515) included in meta- analyses.
Huss xxxviii 2008	21 RCTs	14,603 older adults living in community. Mean age 73 to 80y. 9 RCTs included people with various impairments	Multi-dimensional preventive home visit programmes. Mean no. home visits 4.3 (range up to 12).	Usual care. 4 studies also reported interventions in controls.	4 to 48 mnths	Mortality, nursing home admissions, functional decline.	Beneficial effect on mortality seen in younger (<77 y) study populations (OR 0.74 95%CI 0.58 to 0.94). Functional decline reduced with home visit programmes involving clinical examination on initial assessment.	

Table 3: Systematic reviews of interventions to reduce hospital utilisation and/or death in 'high risk' or 'frail' older people living in the community

Reference	Population	Intervention	Comparator	Outcomes	Results	Comments
Bouman ^{xxxxx} 2008	330 older people aged 70-84 living in community identified as 'high risk' via self-report postal survey (sent to 4901).	160 received ≥ 8 home visits by an experienced nurse over 18 months.	170 received usual care	Self-rated health, functional status, quality of life, changes in self- reported problems, mortality and service use.	No difference in outcomes between intervention and comparator groups.	No info available on screening postal survey used
Van Hout [≾] 2010	651 frail elderly aged 75+ living at home, but neither terminally ill nor demented.	Proactive home visits (average 3) by trained community nurses.	Usual care	Functional health, instrumental ADLs, time to acute hospital admission, institutionalisation, mortality.	No difference between intervention and usual care groups on any outcome measures.	Higher risk of hospital admission for people with poor health (i.e. frailest) in intervention group.
Monteserin ^{xli} 2010	620 people, aged 75+, living in community. In baseline CGA, 46% were identified as at risk of frailty.	Targeted intervention (individual or group sessions) via geriatrician depending on level of frailty.	Usual care	Composite of all causes of death, nursing home admission, admission to home care programme; reversal of frailty to healthy status.	Reduced risk of composite endpoint after intervention in patients at risk of frailty (P=0.028); no. of people with reversal of frailty higher in intervention than control group (P=0.027).	
Ploeg ^{xlii} 2010	719 people, aged 75+, at risk of functional decline, identified via Sherbrooke postal questionnaire (sent to 3166).	Assessment and preventive primary care via experienced nurses.	Usual care	QALYs, costs of health and social services, functional status, self rated health, and mortality.	No difference between intervention and usual care groups on any outcome measures.	Sherbrooke postal questionnaire reported to have 75% sensitivity, 52% specificity, and a PPV of 38% for functional decline. ^{xliii}

Table 4: Randomised controlled trials of interventions to reduce hospital utilisation and/or death in 'high risk' or 'frail' older people living in the community

61. Table 5 shows the summary results from studies identified in this report. Results from two systematic reviews show that geriatric assessment in general elderly or frail elderly populations can reduce risk of hospital admission. Results from three systematic reviews show that preventive home visiting programmes and geriatric assessment can reduce risk of mortality in general elderly and frail elderly populations.

Table 5: Summary results from studies showing effect of interventions o	n hospital admissions
and/or mortality	

First author; systematic review (SR) or randomised controlled trial (RCT)	Intervention and population	Effect on hospital admissions	Effect on mortality
Huss SR	Preventive home visiting programme	-	Reduced risk of death in people <77 yrs
Beswick SR	Geriatric assessment in frail elderly	Reduced risk of hospital admission	No effect
Stuck SR	Comprehensive geriatric assessment in general older population and in frail elderly	Reduced risk of hospital admission	Reduced mortality at 36 months (community settings) and at 6 + 12 months (institutional settings)
Elkan SR	Home visiting in general elderly and frail elderly populations	No effect shown.	Reduced mortality in general elderly and in frail elderly.
Monteserin RCT	Targeted intervention by geriatrician		Reduction in combined risk of death or admission to nursing home or home care programme

62. In summary, therefore, evidence from systematic reviews shows that home visiting and geriatric assessment interventions can be effective at reducing risk of hospital admission and/or mortality in both general elderly and frail elderly populations. It is not clear from the studies presented in this report whether earlier intervention would have led to further improvement in outcomes. Therefore, this criterion is partially met.

There should be agreed evidence-based policies covering which individuals should be offered treatment and the appropriate treatment to be offered

63. No evidence-based policies were found.

Clinical management of the condition and patient outcomes should be optimised in all health care providers prior to participation in a screening programme

64. No evidence was found to enable appraisal of the screening programme against this criterion.

The Programme

There should be evidence from high quality randomised controlled trials that the screening programme is effective in reducing mortality or morbidity.

- 65. To appraise a screening programme in old age against this criterion there would need to be evidence from a randomised controlled trial in which the study population was randomised to one of two groups. The first group would complete a screening test followed by more detailed assessment and treatment if indicated; the second group, the controls, would not complete the screening test and would receive usual care. The study would also need to investigate the effect of the intervention on hospital admission and/or death.
- 66. The RCT by Fletcher et al^{xliv}, used to inform the UKNSC policy in 2006, was a large, cluster-randomised trial in the UK involving 43,219 people aged at least 75 registered with 103 general practices. All study participants were asked to complete a 25-item questionnaire with prior randomisation at practice level to either a postal questionnaire or to one administered by a lay person or nurse. After completing the questionnaire, they were randomised to receive either universal detailed assessment by a study nurse or targeted assessment for those with three or more problems or one of four serious symptoms identified by the questionnaire. After assessment, participants were randomised to management by a geriatric or primary care team. Measured outcomes included mortality, hospital and institutional admissions, and quality of life. The study reported no significant difference in outcomes between universal and targeted assessment groups or between groups managed by geriatric and primary care teams.
- 67. The researchers considered the universal assessment arm of the trial to be equivalent to the annual assessment required by the general practice contract in place at that time and therefore viewed the group randomized to this arm of the trial as the control group. However, since the study did not randomise participants to a control group who did not complete the initial 25-item screening questionnaire, the study does not provide evidence on the effectiveness of a screening programme in the elderly compared with no screening. Instead, it provides information on the relative effectiveness of universal detailed assessment versus targeted detailed assessment and on the relative effectiveness of management by the geriatric team or primary care team.
- 68. No randomised controlled trials, published since 2004, were found investigating the effectiveness of a screening programme in old age and its impact on hospital admission and/or death. The criterion is not met.

There should be evidence that the complete screening programme (test, diagnostic procedures, treatment/ intervention) is clinically, socially and ethically acceptable to health professionals and the public

69. No evidence was found relating to the acceptability to health professionals and the public of a complete screening programme in old age. The criterion is not met.

70. The remaining UK NSC criteria relating to the screening programme have not been considered here due to lack of evidence on the effectiveness of a screening programme in old age.

Implications for policy

- 71. In this review of the evidence on screening in old age to reduce hospitalization and/or early death, only two UK NSC screening criteria on the importance of the condition and the availability of effective treatments or interventions are considered to be met or partially met. The other UK NSC screening criteria are not met.
- 72. The evidence presented in this review does not therefore support a change to the current UK NSC policy that systematic screening in old age is not recommended.

Implications for research

73. Areas for further research include:

- systematic review to assess the performance of different measurement tools in identifying community-dwelling older people at risk of hospital admission and/or early death
- identification of the measurement tool/s which is/are the best predictors of adverse outcomes, including hospital admission and/or early death in community-dwelling older people

Appendix 1: Search strategy

SOURCES SEARCHED: Medline (OvidSP), Embase, PsychINFO, Cinahl, and the Cochrane Library.

DATES OF SEARCH: January 2003 – May 2012

SEARCH STRATEGY:

- 1. (Community Assessment Risk Screen or CARS).tw. (3473)
- 2. Bright tool.tw. (1)
- 3. PRISMA-7.tw. (1)
- 4. Strawbridge Questionnaire.tw. (1)
- 5. Functional assessment screening package.tw. (0)
- 6. (SHARE Frailty Index or SHARE-FI).tw. (5)
- 7. Tilburg Frailty Indicator.tw. (6)
- 8. Comprehensive Geriatric Assessment.tw. (653)
- 9. (Empirical Methods or EM).tw. (34302)
- 10. (Functional Assessment Screen Index or FAS).tw. (20576)
- 11. (Geriatric Postal Screening Survey or GPSS).tw. (28)
- 12. PraPlus.tw. (1)
- 13. (Sherbrooke Postal Questionnaire or SPQ).tw. (301)
- 14. Complexity Prediction Instrument.tw. (5)
- 15. (Hospital Admission Risk Profile or HARP).tw. (487)
- 16. (Identification of Seniors at Risk or ISAR).tw. (168)
- 17. Geriatric Assessment/ (15901)
- 18. ((multidisciplinary or multi-disciplinary) adj (assessment or screen\$ or question\$ or inventory or evaluation)).tw. (579)

19. ((multidimensional or multi-dimensional) adj (assessment or screen\$ or question\$ or inventory or evaluation)).tw. (778)

20. ((multifactorial or multi-factorial) adj (assessment or screen\$ or question\$ or inventory or evaluation)).tw.(94)

- 21. screen\$3.ti. (99893)
- 22. (screening adj (tool* or letter* or questionnaire*)).tw. (10001)

23. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 (182284)

- 24. aged/ or "aged, 80 and over"/ (2094772)
- 25. (old\$ people or old\$ adult\$ or geriatric\$ or senoir\$ or elder\$ or aging or ageing or aged).tw. (561133)
- 26. 24 or 25 (2390003)
- 27. ((early or premature) adj death\$).tw. (8519)
- 28. frailty.tw. (2694)

29. ((patient or hospital or institution\$2 or nursing home) adj (admission\$ or stay)).tw. (57001)2

- 30. hospitali?ation.tw. (68644)
- 31. (functional adj (decline or status)).tw. (16443)
- 32. (independence or autonomy).tw. (37819)
- 33. "Activities of Daily Living"/ (44716)
- 34. Morbidity/ (21478)
- 35. Mortality, Premature/ or Mortality/ (32072)
- 36. quality of life.tw. (118625)
- 37. "Outcome Assessment (Health Care)"/ (41913)
- 38. health-related characteristic\$.tw. (169)
- 39. 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 (404208)
- 40. 23 and 26 and 39 (8244)

41. exp child/ (1432200)
42. exp middle age/ (2985431)
43. 41 or 42 (4123254)
44. 40 not 43 (5716)
45. systematic.tw. (128513)
46. meta-analys?s.tw. (41506)
47. (randomi?ed or RCT\$).tw. (313639)
48. (case-control or longitudinal).tw. (178331)
49. (prospective or retrospective).tw. (501916)
50. 45 or 46 or 47 or 48 or 49 (1025239)
51. 44 and 50 (1513)
52. limit 51 to yr="2003 -Current" 985

Similar searches were also carried out in Embase, PsychINFO, Cinahl, and the Cochrane Library. All searches were carried out on 23 May 2012

Appendix 2: Leading causes of death in males, England and Wales, 2010

Rank	Underlying cause of death	Number of deaths	Percentage of all male deaths	Age-standardised mortality rate per 100,000 population
1	Ischaemic heart diseases (I20-I25)	40,721	17.1	108.3
2	Cerebrovascular diseases (I60-I69)	16,909	7.1	42.2
3	Malignant neoplasm of trachea, bronchus and lung (C33, C34)	16,807	7.1	46.5
4	Chronic lower respiratory diseases (J40- J47)	13,137	5.5	33.4
5	Influenza and Pneumonia (J09- J18)	10,620	4.5	26.3
6	Malignant neoplasm of prostate (C61)	9,638	4.1	23.8
7	Malignant neoplasm of colon, sigmoid, rectum and anus (C18- C21)	7,700	3.2	21.1
8	Dementia and Alzheimer's disease (F01, F03, G30)	7,347	3.1	17.1
9	Malignant neoplasms of lymphoid, haematopoietic	5,826	2.4	16.1
	and related tissue (C81-C96)			
10	Diseases of the liver (K70- K76)	4,724	2.0	15.9
	All male deaths	237,916		

Source: ONS

Rank	Underlying cause of death	Number of deaths	Percentage of all female deaths	Age-standardised mortality rate per 100,000 population
1	Ischaemic heart diseases (I20-I25)	29,475	11.5	47.8
2	Cerebrovascular diseases (I60-I69)	26,454	10.4	39.6
3	Dementia and Alzheimer's disease (F01, F03, G30)	17,759	7.0	23.5
4	Influenza and Pneumonia (J09- J18)	14,903	5.8	21.5
5	Malignant neoplasm of trachea, bronchus and lung (C33, C34)	13,170	5.2	29.9
6	Chronic lower respiratory diseases (J40- J47)	12,848	5.0	23.8
7	Malignant neoplasms of female breast (C50)	10,290	4.0	24.5
8	Diseases of the urinary system (N00-N39)	7,365	2.9	10.7
9	Heart failure and complications and ill-defined heart disease (I50-I51)	6,461	2.5	9.0
10	Malignant neoplasm of colon, sigmoid, rectum	6,402	2.5	12.9

Appendix 2 (cont.) Leading causes of death in females, England and Wales, 2010

Source: ONS

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