



RESEARCH

INFORMATION

Derivation of a hospital episode frailty index from electronic patient records: Understanding the role of frailty in health outcomes for older hospital patients in Scotland



AIMS

This project tested the feasibility of using information within routinely collected health records to identify frail patients in hospital. Frailty describes the loss of strength and physical reserves that affects some older adults and puts them at increased risk of harm during or after a hospital stay. Identification of these patients without requiring individual patient casenote review could help to target earlier specialist care to those at risk of dependency or complications after an illness.



KEY FINDINGS

- Frailty can be defined by accumulation of health deficits over time – areas of body function that start to show weakness or signs of failure. Identification of 12 core health deficits was possible from routinely entered hospital data in this project. These broadly covered problems in areas of memory, daily living tasks (e.g. washing and dressing independently), continence, falls, poor nutrition, mobility and skin health.
- These were combined in a new tool – the *Continuous Dynamic Evaluation of frailty (CoDE-f)* score – which has now been tested in a series of studies. In a pilot study of 186 older patients admitted to a cardiology ward, a prototype of the CoDE-f score identified similar patients as high risk when compared to traditional frailty measures which rely on face-to-face assessment and special equipment.
- In a routine data study of 2,023 patients with memory issues on admission to hospital, the CoDE-f score predicted the risk of death, a new diagnosis of dementia and requirement for transfer into a care home. This was further evaluated in 47,305 consecutive older patient admissions to the medical units of three Lothian hospitals, with a clear relationship between the admission CoDE-f score and risk of longer hospital stays or earlier death.
- The CoDE-f score is now used at the Royal Infirmary of Edinburgh to help identify older patients who may benefit from specialist geriatric medicine assessment. This saves clinician time and makes full use of data already entered into health records as part of routine care.





WHAT DID THE STUDY INVOLVE?

There is a large volume of information about a patient routinely collected by healthcare staff at the point of hospital admission. This includes nursing assessments performed as part of national standards to protect older patient safety, called the Care Assurance Standards. This information is routinely collected, but rarely use to triage care needs. In our engagement work, hospital patients frequently reported being asked the same questions repeatedly by different staff during an admission, indicating these findings were not well flagged in the electronic records.

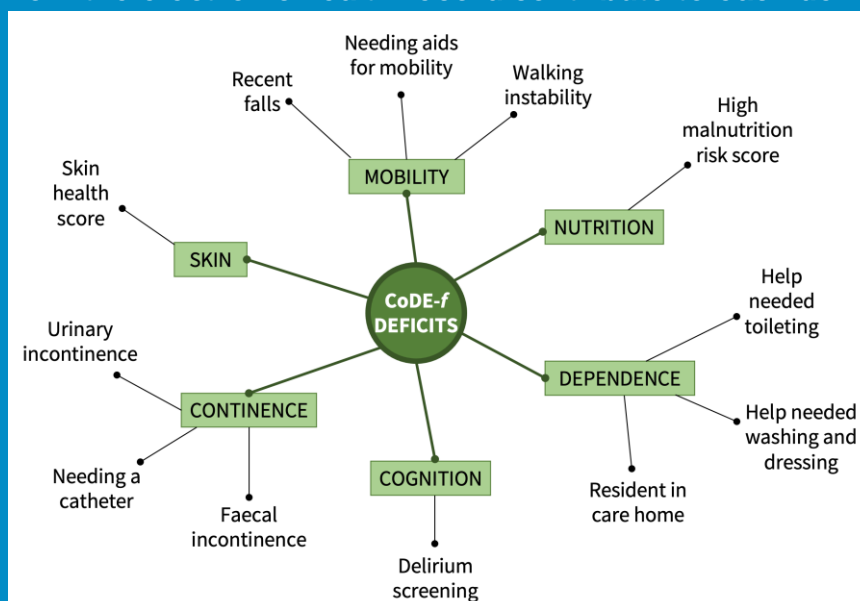
All these routinely entered data were reviewed for completeness, ease of data extraction and relationship with future complications like spending longer in hospital before discharge. The final list of items included in the CoDE-*f* score covered 31 data items that could be distilled down into 12 core health 'deficits' (see Figure below). In common with other frailty measures like this (collectively called 'frailty indices'), each deficit is given equal importance, and a score is generated from the number of possible deficits an individual person has on their record.

Two types of studies were used to assess the value of the CoDE-*f* score:

1. A face-to-face consented study of 186 older patients to test if CoDE-*f* was really identifying people with frailty. Here, the score was manually calculated and compared to additional frailty measurements – these were carried out using measures of muscle strength, walking speed, balance and questionnaire responses.
2. Large data studies to calculate the CoDE-*f* score in consecutive hospitalised patients and compare this to outcomes such as length of hospital stay, unplanned readmission, move to a care home, development of dementia and death.

The CoDE-*f* score has now been automated by the NHS Lothian analytics team to provide a regular daily report for the Royal Infirmary of Edinburgh. Patient representation was involved in the design of the face-to-face validity study. We are now designing trials to understand if offering more specialist care to patients with higher CoDE-*f* scores could improve outcomes.

This diagram shows the core health deficits within the CoDE-*f* score. Multiple data points from the electronic health record contribute to each deficit.





WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

Initial testing showed that around a third of patients in hospital aged over 65 years old had a least one of these 12 health deficits noted in their records. On average, each time an additional deficit was recorded, a patient spent an extra 5.5 days in hospital. We know that on average older patients tend to spend longer in hospital, but the count of CoDE-f deficits was more important than age in predicting the length of admission.

Consented study

In the targeted study of 186 patients on a single ward, the CoDE-f score was calculated at the same time as additional traditional frailty measures, including those requiring extra equipment to measure muscle strength, walking speed and balance. The CoDE-f score was as good as these traditional frailty tools for the predicted risk of:

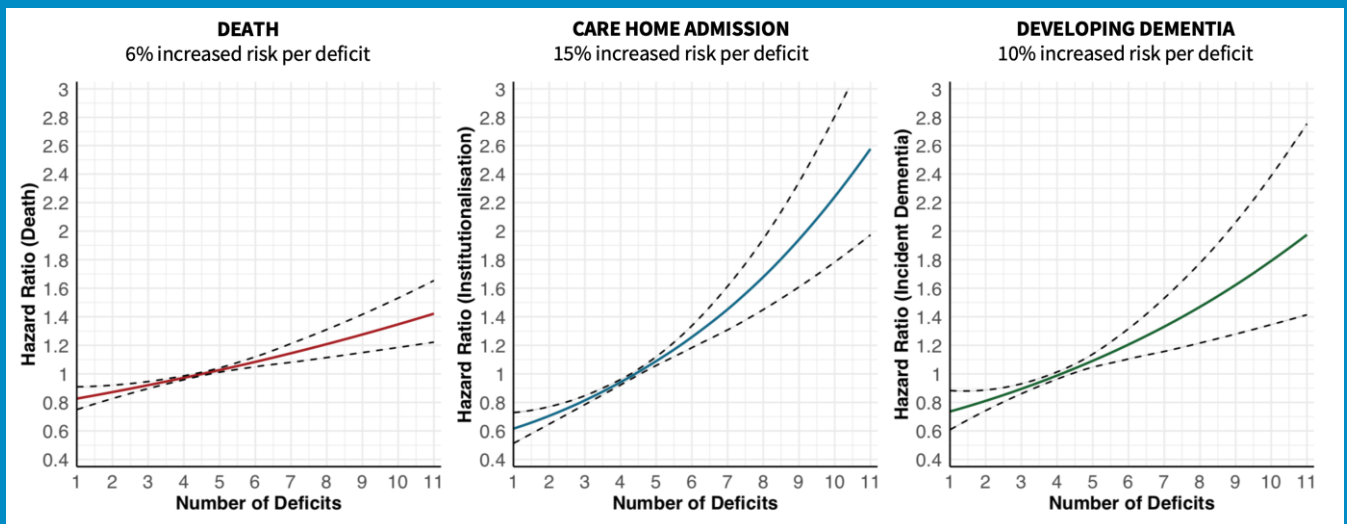
- readmission to hospital or death within 90 days of hospital discharge
- death within a year of hospital discharge
- spending fewer days at home (out of hospitals or clinics) over the year after discharge

The CoDE-f score was also a better predictor of these outcomes than just knowing about the number of health conditions a patient has (known as comorbidities).

Large data studies

The next study used routine data from over 2,000 patients admitted with memory issues (identified by an abnormal screening test result on hospital admission). The additional information provided by the CoDE-f score appeared important for predicting future risk of outcomes over the next two years as shown below:

In 2,023 consecutive patients with memory problems, more health deficits increases the risk (the hazard ratio) of dying, being admitted to a care home or developing dementia in the next 2 years. The results are after adjustment for the differences in age and sex as the number of health deficits increase.



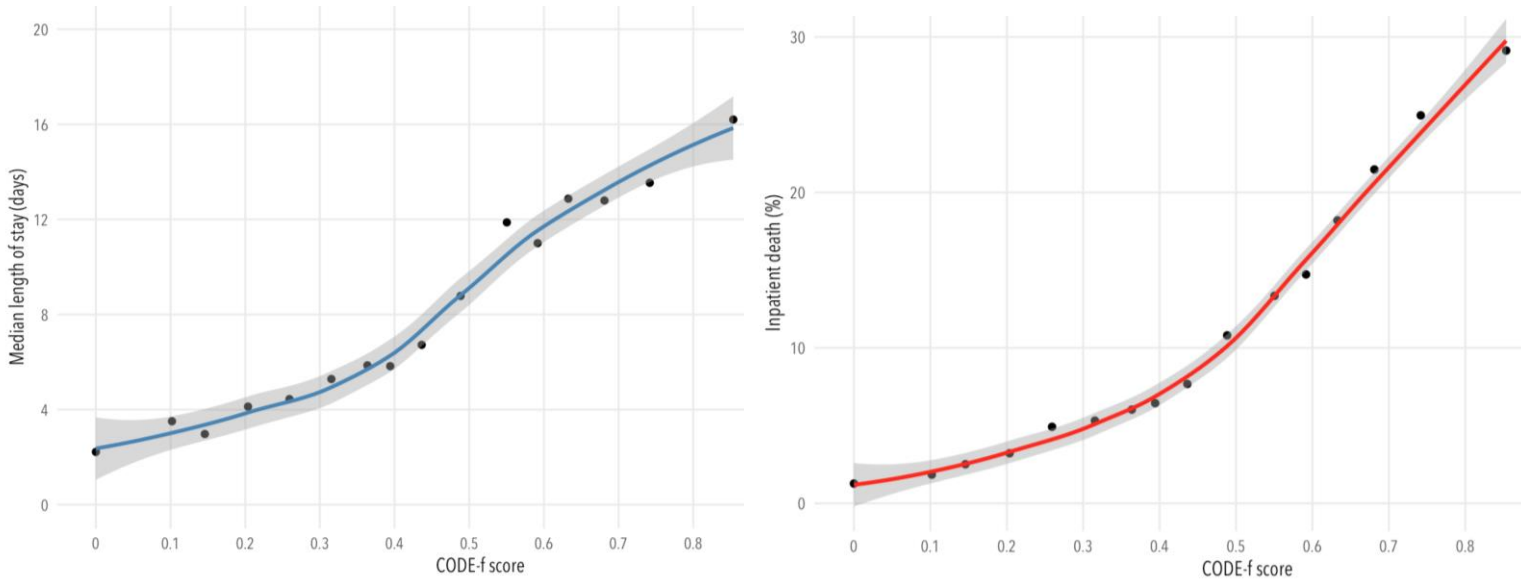
The coloured lines show the average increase in risk as deficits accumulated moving left-to-right in each plot. The dotted lines show the confidence lines where we would expect the risk of 95% of patients to lie.



It was important to make sure that these findings were not just limited to the selected patient populations described above and to understand any problems with missing data. So the next study included data from every older patient admitted to the medical units of 3 NHS Lothian hospitals over a four year period. This included 47,305 hospital admissions from 23,145 different patients.

In this study, the CoDE-*f* score was reported as the proportion of available deficits a patient had in their records. This makes it more standardised between patients. For example, a patient with 3 out of 12 possible deficits would have a score of $3/12 = 0.25$. This score could be calculated in 87% of all patient admissions. The remaining minority of patients did not have enough relevant information entered into their record to generate a score reliably.

The results were similar to the earlier work. Increasing CoDE-*f* scores were seen in patients who spent longer in hospital (blue line below) and had a higher risk of dying during their admission (red line):



These graphs show increasing CoDE-*f* score moving left-to-right with longer length of hospital stay (blue line) and risk of dying in hospital (red line).

The real potential of these results are that the CoDE-*f* score uses information that is already reliably entered as part of the hospital admission process. This means that the score can be calculated in real-time without additional effort for the majority of patients. As a response to the COVID pandemic, an automated approach was adopted for the screening of new older patient admissions at the Royal Infirmary of Edinburgh. Previously, specialist geriatric medicine nurses would spend up to 2 hours each day reading and screening the notes of all new medical admissions over 65 years old for signs of frailty. Now, an automated screening report is produced daily showing the calculated CoDE-*f* score for every patient in the hospital. The specialist nurses can now focus their attention on those new patients scoring highest for frailty at the start of each day. This has released specialist nursing time for direct patient care. We are now testing how the CoDE-*f* score changes during a patient's admission and whether it can accurately track deteriorations or recovery over time.





WHAT IMPACT COULD THE FINDINGS HAVE?

- This project has demonstrated that routinely collected hospital data can be used to automatically screen older people admitted to hospital and identify patients at risk of complications during or after their admission.
- This could help target specialist care and extra attention to those who most need it.
- For patients and carers, this also means that information they share with nurses when first admitted to hospital is better used to provide individualised care.
- For hospital services, this has potential to improve care efficiency and release staff time for direct patient care. This should ultimately improve patient outcomes.



HOW WILL THE OUTCOMES BE DISSEMINATED?

The initial results of this project have already been presented to the British Geriatrics Society, where they were selected for the 'President's Round' of high quality research submissions. A paper detailing the initial methods and testing has been published in the journal *Age and Ageing* and a further publication on outcomes for patients with acute confusion (known as delirium) has also been published.

We are now adding in additional measures that are available in patient records that were not available for research at the time this work was started. This includes some records from GP practices. This could substantially improve the CoDE-*f* score and make it even more personalised to an individual patient's risk. Newer computing techniques called machine learning can help spot subtle patterns in data that may not have been identified by the methods used so far. We are keen to explore machine learning to improve the accuracy of the CoDE-*f* score even further. Ultimately, we would like to plan a trial to test changes to care directed by the CoDE-*f* score to see if this improve outcomes for patients. Ideas for this will be co-designed with patient and public involvement.



CONCLUSION

Routinely collected information recorded in our electronic hospital health records can help to identify patients at risk of future deterioration. This project has created a new tool, the CoDE-*f* score, which can be used to screen older patients and help target specialist care in real-time. By automating this approach, clinical time can be released for care to improve the efficiency of how we deliver hospital services. Ultimately this work has shown that patients at risk of harmful outcomes can be identified at the point of hospital admission. We now aim to design a trial to better the care pathways that follow admission to improve outcomes for older people in hospital.



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