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Citation for final published version:

Hewitt, Jonathan , Long, Sara , Carter, Ben, Bach, Simon, McCarthy, Kathryn and Clegg, Andrew 2018. The prevalence of frailty and its association with clinical outcomes in general surgery: a systematic review and meta-analysis. *Age and Ageing* 47 (6) , pp. 793-800. 10.1093/ageing/afy110

Publishers page: <http://dx.doi.org/10.1093/ageing/afy110>

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# The Prevalence of Frailty and its association with clinical outcomes in General Surgery: A Systematic Review and Meta-Analysis.

## ABSTRACT

**OBJECTIVES:** To investigate the prevalence and impact of frailty for general surgical patients.

**RESEARCH DESIGN AND METHODS:** We conducted a systematic review and meta-analysis. Studies published between January 1980 and August 31<sup>st</sup> 2017 were searched from 7 databases. Incidence of clinical outcomes (mortality at day 30 and day 90; readmission at day 30; and surgical complication) were estimated for patients categorized into frailty subgroup (not-frail, pre-frail, and frail). Both emergency and elective studies were included.

**RESULTS:** 2281 participants from 9 studies were included, 49.3% (1013/2055) were male. Mean age ranged from 61 to 77 years old. The prevalence estimate of frailty ranged between 31.3%-45.8% for pre-frailty and 10.4%-37% for frailty. After pooling, day 30 mortality was 8% (95% CI 4 to 12%;  $I^2=0\%$ ) for frail compared to 1% for non-frail patients (95% CI 0 to 2%;  $I^2=75\%$ ). Due to heterogeneity the day 90 mortality was not pooled. Re-admission rates were 18% (95% CI 11 to 24%;  $I^2 = 75\%$ ) in the frail and 11% (95% CI 7 to 14%;  $I^2=78\%$ ) in the non frail. Complications in the frail patients was 24%, (95% CI 20 to 31%;  $I^2=92\%$ ) and in the pre-frail subgroup 9% (95% CI 5 to 14%;  $I^2=82\%$ ) 5% (95% CI 3 to 7%;  $I^2=70\%$ ) in the non frail. The mean length of stay in frail people was 9.57 days (95% CI 6.24 to 12.90) and 6.44 days (4.91 to 7.92) in the non frail,

**CONCLUSIONS:** Frailty is associated with adverse post-operative outcomes in both emergency and elective general surgery.

## Background

Frailty is a condition characterised by loss of biological reserves, failure of homeostatic mechanisms and vulnerability to adverse outcomes following stressor events such as

surgery. Delivery of surgical care becomes more challenging in this context (1). Faced with an ageing population whose rate of general surgical intervention is increasing rapidly, awareness of frailty is becoming more widespread in surgical and critical care settings(2). Similarly, the importance of the identification and management of the frail patient is increasingly being recognized(3). A modest but increasing number of studies have recently assessed a number of different frailty tools in both emergency and elective general surgery against a range of outcomes. However, no systematic reviews have yet attempted to give an overview of their use.

The aim of this review was to assess frailty prevalence and its association with clinical outcomes across general surgical specialties.

## **Methods**

This study was carried out following PRISMA guidelines. The review was registered and the protocol is available on Research Registry (reviewregistry129, <http://www.researchregistry.com>)

### **Search strategy**

We searched seven electronic databases (Medline, CINAHL, The Cochrane Library, AMED, PSYCINFO, EMBASE and Web of Science) for manuscripts published from January 1<sup>st</sup>, 1946, to August 31<sup>st</sup>, 2017. All identified and relevant studies' references were manually reviewed to identify any potential studies that apply or support the study hypothesis. The search terms were based on MeSH terms (Medical Subject Headings) and other controlled vocabulary. Search terms relating to surgery, frailty and risk factors were used. The search strategy is outlined in supplementary file 1.

### **Eligibility criteria and study identification**

The review process is summarised in a PRISMA flow diagram (Figure 1).

Randomized controlled trials; cohort studies; and case-control study designs were eligible for inclusion. Only studies using a validated method of frailty identification were included(3). Studies that used large scale database analysis assessing frailty and surgery were excluded(4). Studies based solely in intensive care were excluded since these populations are atypical and could introduce additional confounders. No language restrictions were applied

Two reviewers (JH, SL) searched the literature and assessed the studies for eligibility independently; disagreements were resolved through discussion with a third reviewer (BC).

### **Data extraction and quality assessment**

Demographic information, frailty tool, frailty prevalence and outcomes data were extracted from the included studies independently by two reviewers (JH, SL) disagreements were resolved through discussion with a third reviewer (BC).

Study authors were contacted to clarify or provide additional data where it was missing or unclear.

For the studies included the quality assessment was conducted by two reviewers independently (JH, SL) and arbitrated by a third (BC) using the Newcastle-Ottawa Scale (NOS)(5), which assesses the risk of bias of observational studies. Scores were assigned for selection criteria, comparability and outcome. Each domain examined was determined as of acceptable quality, unclear or not acceptable. A maximum score of 9 reflects highest quality. If a study was scored 7-9, it was categorized as a good study, 4-6 as fair quality and 0-3 as poor quality.

### **Data analysis**

Frailty prevalence was estimated using studies that had categorized frailty using standard specific cut-offs for validated frailty tools (6-10) For consistency, prevalence was not calculated using studies where participants were defined as being frail using a non-standard cut-off.

Data were extracted for the following primary outcomes: short term mortality (30 day), and medium term (3 to 6 months) term mortality. Further data were extracted for the following secondary outcomes: 30 day readmission to hospital, complications and length of hospital stay. All outcomes captured dichotomous data except for the length of stay, and the treatment effects were measured by the proportion of patients experiencing the outcome. Continuous data for the length of stay were skewed, so were transformed and summary statistics were calculated on the transformed scale. Frailty subgroups were used to explore the association between frailty and outcomes. If study design and population did not exhibit clinical heterogeneity, data were pooled

in a random effects meta-analysis. All the meta-analysis was conducted using Stata version 13.0.

### **Assessment of subgroups and statistical heterogeneity**

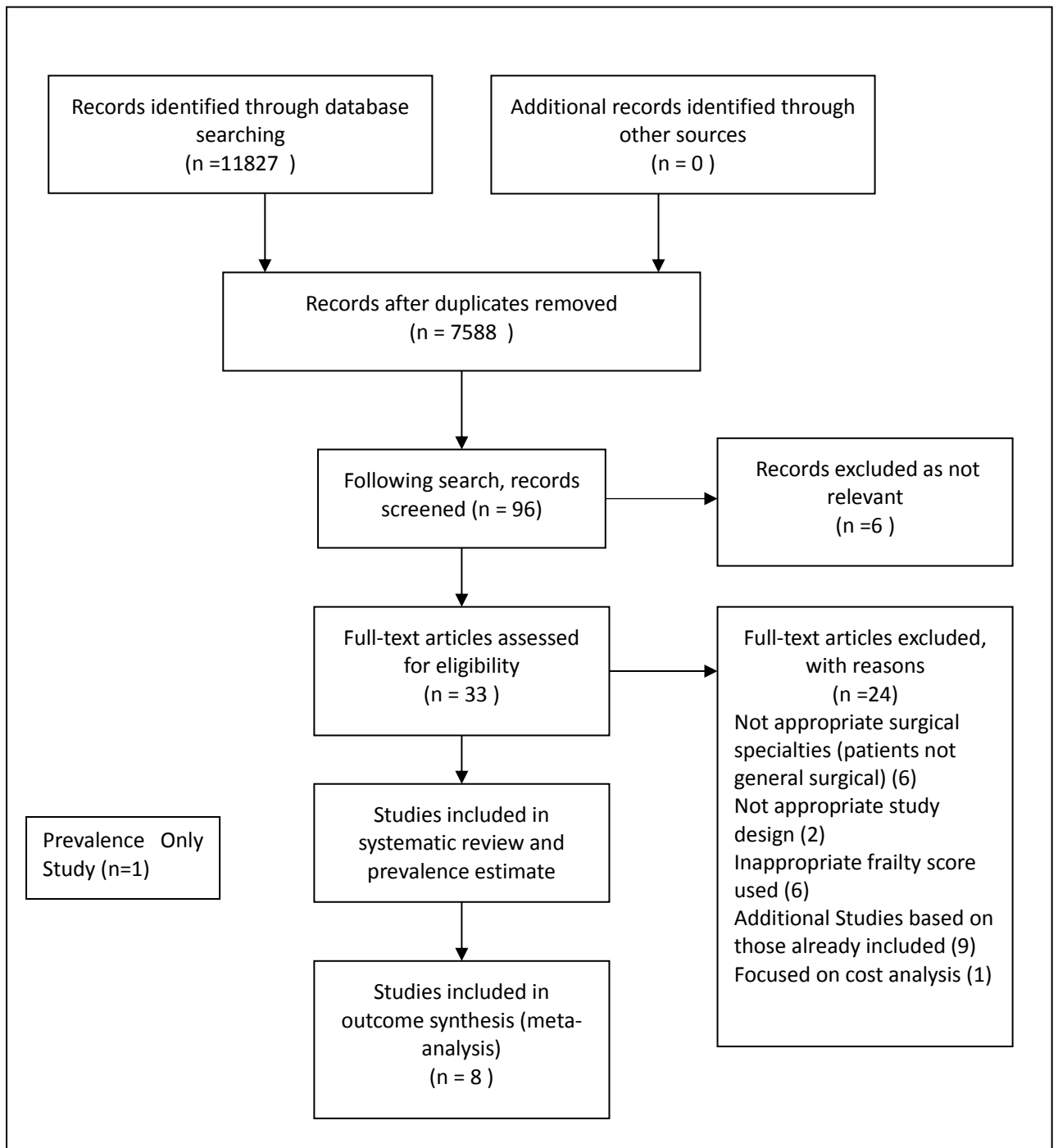
Heterogeneity was assessed using the  $I^2$  statistic, and pooling that exhibited an  $I^2$  over 85% was explored using subgroup analyses. All meta-analyses were presented as an estimated proportion, associated 95% confidence (95% CI), P-values and  $I^2$  summary data. Frailty was a pre-specified subgroup to explore the association between frailty and outcomes. Patients were categorized as non-frail, pre-frail or frail. The following pre-specified subgroups were used to explain heterogeneity: quality assessment (high quality, versus unclear and low quality studies); age of patients (65 to 70; 70 to 80; 80+); type of surgery (elective; emergency; or combined).

## **Results**

### **Identified studies and quality assessment**

After removal of duplicates, 5994 records were identified, and led to 21 full texts being reviewed, where 12 were excluded. Nine were included in this analysis and are shown in the PRISMA diagram (Figure 1)(11-19). One study only considered frailty prevalence (11). This study was not considered in the meta-analysis or the quality assessment (Supplementary Table 1). Five studies were determined as good quality(12, 13, 15, 17, 20), three were categorized as fair quality(14, 16, 19) and none were categorized as poor quality. The average NOS score was 8.3. For further details of the results of the quality assessment tool, see Supplementary Figure 1.

**Figure 1: PRISMA Flowchart of included studies**



## **Characteristics of the included studies**

From the 9 studies 2281 patients were included, 49.3% were male (1013/2055) and six studies only recruited older patients (over 65 year olds), the mean age ranged from 61 to 77 years old (Supplementary Table 1).

## **Frailty Prevalence**

The 9 included studies used a range of frailty assessment tools, of which seven were deemed suitable for inclusion in the prevalence estimation. One study(17) oversampled complex cases, as such it was not a representative sample to be included in the prevalence data. The other excluded study used a range of frailty scales and was not suitable for inclusion(14). Of the included studies, two used the phenotype model(11, 15)), two the Groningen Frailty Indicator (16, 20), two the deficit based model (12, 13) and one a seven point assessment of frailty traits (9). The prevalence of pre-frail ranged between 31.3%-45.8%, frailty prevalence ranged between 10.4%-37%. The included studies and the prevalence estimated are shown in Supplementary Table 2.

## **Primary outcome:**

### **Short term mortality (Day 30), and medium term mortality (Day 90 to Day 180).**

Three studies reported mortality at Day 30 (12, 13, 16), this included 9% (17/192) patients who were determined as frail, and 3% (12/479) who were not frail. After pooling the proportion who were frail was 8% (95% CI 4 to 12%;  $I^2=0\%$ ), which compared to 1% who were not frail (95% CI 0 to 2%;  $I^2=75\%$ , Figure 2).

Two studies reported mortality in the medium term (12, 18), 23% (24/105) died who were frail, compared to 11% (34/300) who were not frail. After pooling the proportion who died that were frail was 17% (95% CI 11 to 24%;  $I^2=39\%$ ), compared to 7% who were not frail (95% CI 4 to 10%;  $I^2=93\%$ ; Figure 3). The pooled exhibited severe heterogeneity, and may be unreliable so are not included within Figure 3.

## **Secondary outcomes:**

### **Readmission at Day 30**

Two studies reported the proportion of patients with a re-admission(12, 19) The proportion who were re-admitted in those that were frail was 18% (95% CI 11 to 24%;

$I^2 = 75\%$ ) and 11% (95% CI 7 to 14%;  $I^2=78\%$ ) in those that were not frail, see Supplementary Figure 1.

### **Surgical Complications**

Four Studies reported the proportion of patients who suffered surgical complications (13, 15, 16, 19). Severe clinical heterogeneity was exhibited between the studies, which was explained in part by frailty. The estimated proportion to exhibit complications from the frail subgroup of patients was 24%, (95% CI 20 to 31%;  $I^2=92\%$ , Figure 4) pre-frail subgroup 9% (95% CI 5 to 14%;  $I^2=82\%$ ); and from the not-frail subgroup 5% (95% CI 3 to 7%;  $I^2=70\%$ ). Post operative complications were assessed using a variety of tools, including the Accordion Severity Classification(19), the American College of Surgeons National Surgical Improvement Program definitions(13, 15) and those constructed directly by the study authors(16).

### **Length of Stay**

Four studies presented data on the length of stay and applied cut offs for participants as either frail, or non-frail (9, 12, 13, 20). The pooled mean length of stay in frail people was 9.57 days (95% CI 6.24 to 12.90) and in those who were non-frail was 6.44 days (4.91 to 7.92), see Supplementary Figure 2. However, substantial heterogeneity that could not be explained was found within both of these subgroups so caution is needed when interpreting these findings.

Due to the few numbers of included studies no sensitivity analyses were carried out.

### **Discussion**

This study identified 9 studies, of which 8 were included in the analyses and were quality assessed. Six studied elective and three considered emergency surgical patients. The studies covered a wide range of upper and lower abdominal surgical conditions, including both benign and malignant conditions, five of which were good quality and the remaining three fair quality.

We found clear evidence of an increase in the proportion of patients that suffered mortality and surgical complications in those that were frail, compared to those



patients who were not frail. Pooled analysis identified short term (up to 30 day) and medium term (up to 180 day) mortality to be more frequent in those people who were frail. Post-operative complications and readmission to hospital within 30 days of discharge were also more frequent in frail individuals following their surgical illness.

This review is the first review to characterize frailty in a general surgery patient group. Other recent reviews, whilst also demonstrating that frailty was associated with post-operative complications examined studies from a range of surgical specialties, not solely general surgery, for example Lin and colleagues(21) and the narrative review by Beggs et al (22). This review also differs as it considers eight trials for meta-analysis. Lin et al identified three general surgical articles for review but did not perform meta-analysis. Of the three studies which were considered by those authors, two (12, 14) are considered in this review and one(23) was excluded because of the frailty assessment tool used was constructed by the study authors.

### **Strengths and weaknesses**

In general, all of the studies included were of at least moderate quality, with more than half being judged as good quality, as reflected by the minimum Newcastle-Ottawa-Scale (NOS) result being 6, with an average score of 8.3.

Due to the non-randomised nature of the included studies a combination of: selection bias; performance bias; confounding and reporting bias is possible so the findings of this review should be viewed with caution and with a high risk of bias. However, the strength of evidence linking frailty to poorer outcomes is consistent, with little evidence of heterogeneity in most outcomes, and clearly different for the frailty subgroup, with a dose-response of poorer outcomes linked to frail, compared with the pre-frail subgroup, although the pre frail group was comprised of a comparatively small number of participants. The biological plausibility and a reasonable consistency across the varying studies is indicative that frailty is linked with poorer post-surgical outcomes.

There was heterogeneity found within the post operative complications outcomes, but we believe that this was introduced by differing methods used to assess post operative complications. For example two studies(13, 15) used the American College of Surgery national Surgical Quality Improvement Program definition, one(9) the American

Society Guidelines and another(16) defined their own list of post operative complications to be recorded. Future studies should consider using a standardized post operative complication definition, as this will aid accurate comparison between frail surgical patients across studies.

The quantity of robust published data for individual outcomes was limited. None of the preselected outcome measures were reported in more than four studies and two (medium term mortality and readmission to hospital) were only reported in two studies. Using small numbers of studies for meta-analysis requires a degree of caution when interpreting results, but throughout all of the outcomes there is a consistent and repeated effect of frailty.

A potential limitation was the absence of data from patients with special clinical situations such as intensive care admission. The decision was taken to exclude these data to avoid introducing confounding. However, it should be noted as a potential area for future dedicated systematic review in light of evidence that frailty predicts risk of institutionalization in surgical patients who are admitted to intensive care(9)

The present review found a range of frailty assessment tools were chosen and implemented across the studies which will have introduced heterogeneity. This is to be expected as there are two broad models used for frailty assessment, the phenotype model and the accumulation of deficits model. Both models are valid and can be applied to research and clinical situations with the proviso that staff using these tools are trained in their use(24). The search criteria in this review stated that we would only include studies that employed recognized frailty assessment methods. Eight of the included studies used either phenotype or deficit accumulation models. The only caution and deviation from the inclusion criteria was the decision to include the study by Robinson etal(9). This study did not use an established frailty assessment tool which conformed to either of the models described above. However, the primary author and the associated team have published widely in the field of surgical disease in the older person and the assessment tool they use is robust, validated and is being used by additional research groups. Therefore, following consensus, it was decided to include this study.

It is also of note that one study (18) met our inclusion criteria but did not form part of the analysis. It was not possible to extract data from those contained in the manuscript. No response was received from the study authors for a more detailed breakdown of data which may have been usable. Should future studies wish to revisit this area, perhaps to address a different outcome, these data need to be included for completeness. The findings of the study were all in keeping with the reported meta-analysis and frailty showed an association with morbidity ( $p=0.02$ ).

Additionally we excluded large database type assessments of frailty(4) from our analysis. The primary rationale was three fold. Firstly these studies used frailty assessments derived specifically for each database according to the factors available within them and were not uniform in construction. Secondly, they were of such scale that to have included them would have influenced the results to such an extent that other smaller studies would have had virtually no effect on the outcome measures generated and thirdly none of them used assessments that are used in clinical practice, limiting their day to day utility.

### **Implications for research and clinical practice**

All of the included studies were published since 2010, and it is likely that further studies will be suitable for combination with the data shown here to further reinforce (or repudiate) our findings. Perhaps more importantly, it is likely that additional outcome data will become available for measures such as long term mortality, and for patient-facing measures such as quality of life after surgery and requirement for social care provision. Further research in these areas will allow more comprehensive assessment of the impact that surgical conditions and their management have on frail patients.

By establishing the impact of frailty on both morbidity and mortality, this study further highlights the importance of this clinical condition. Clinicians can use the presence of frailty to predict worse outcomes in general surgery irrespective of age. Where possible frailty should be identified pre-operatively, allowing the use of targeted interventions such as Comprehensive Geriatric Assessment(25, 26) with the aim of optimizing clinical condition prior to surgical management.

## **Conclusions**

This study demonstrated that frailty is common in both elective and emergency general surgery. Despite a limited number of studies included in each of the meta-analyses frailty demonstrated a consistent association with both mortality and morbidity.

**Funding statement:** No funding was received for this study.

## **Contribution of authors:**

JH Conceived the idea, searched the literature, extracted the data, wrote the first draft of the manuscript

SL searched the literature, extracted the data, wrote the manuscript.

BC developed the methods, and carried out the analysis, interpreted the analysis, wrote the manuscript

KM conceived the idea, wrote the manuscript

SPB conceived the idea, wrote the manuscript

AC conceived the idea, wrote the manuscript

JH is the guarantor of this review.

**Figure 2 – Mortality at Day 30**

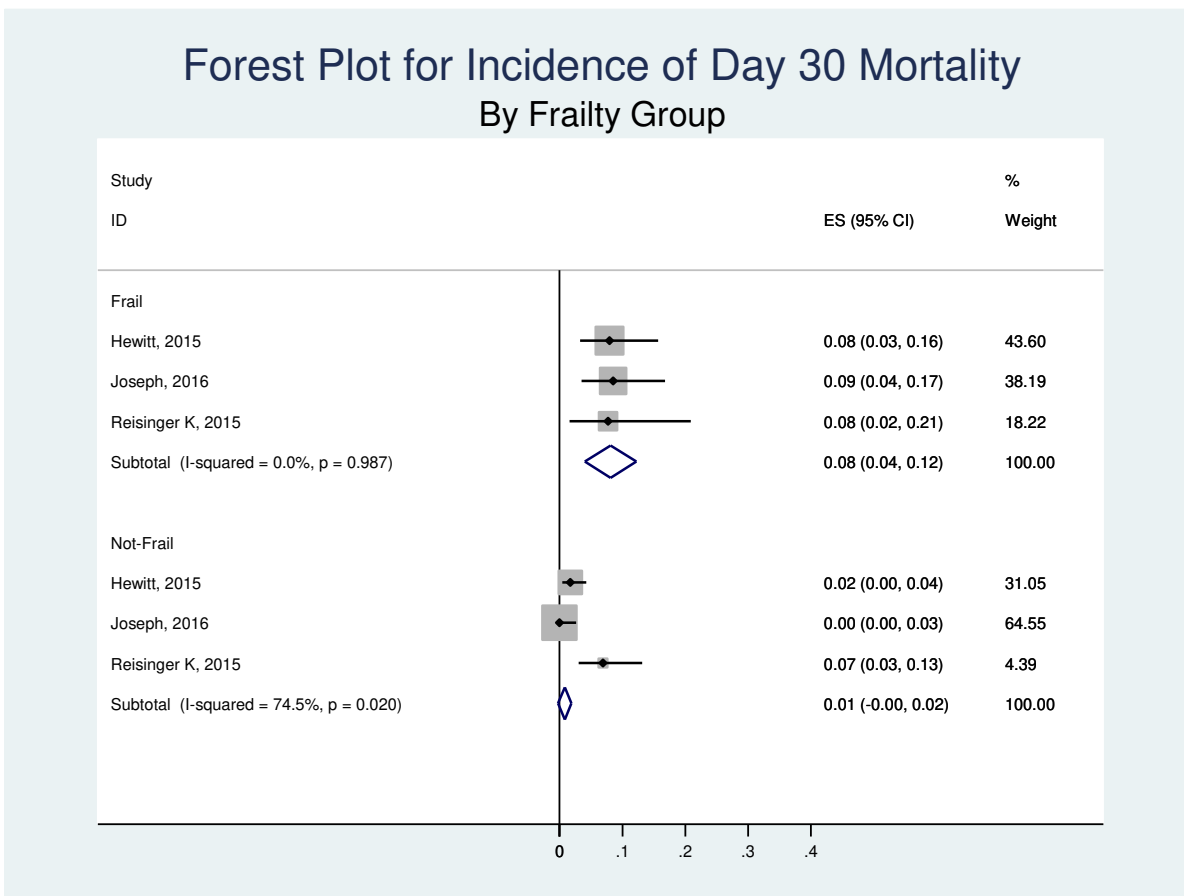


Figure 3 Mortality at Day 90 to 180

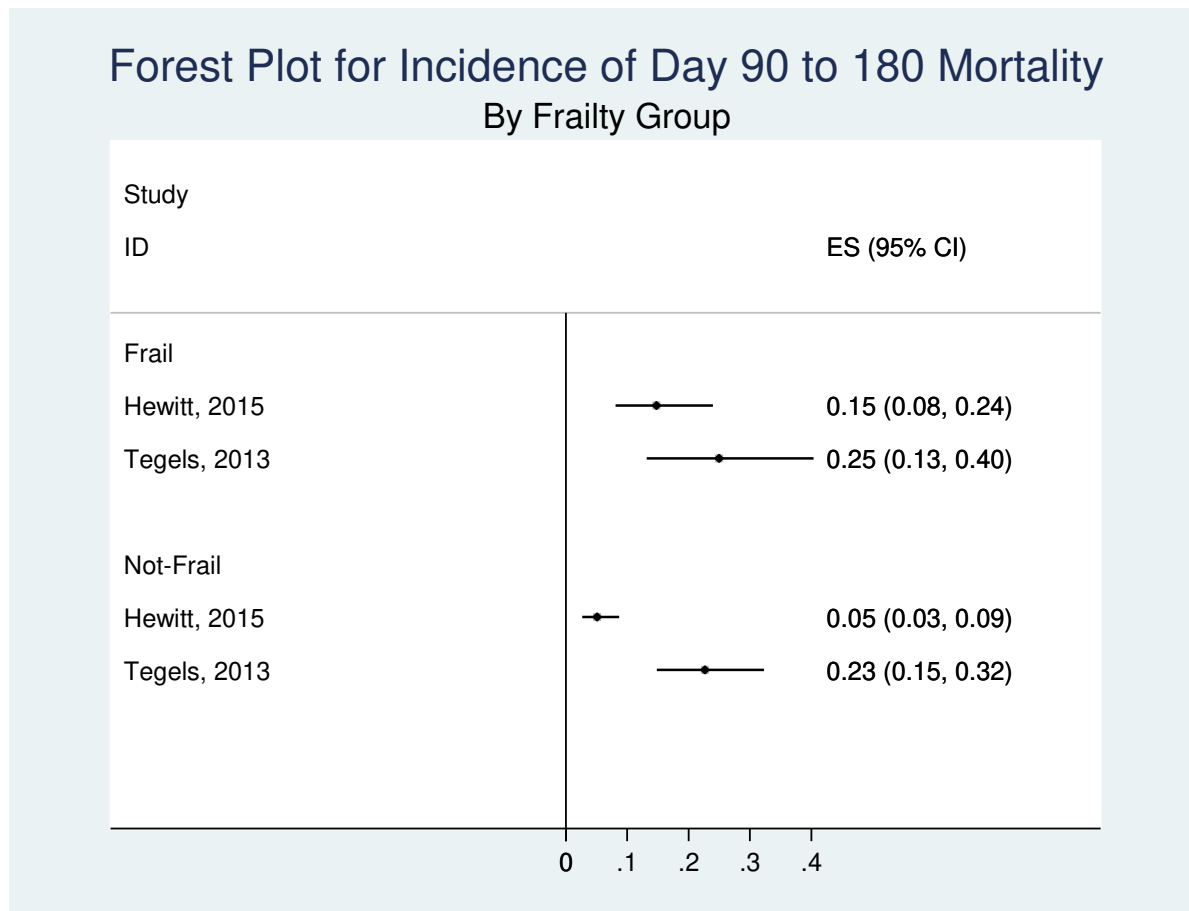
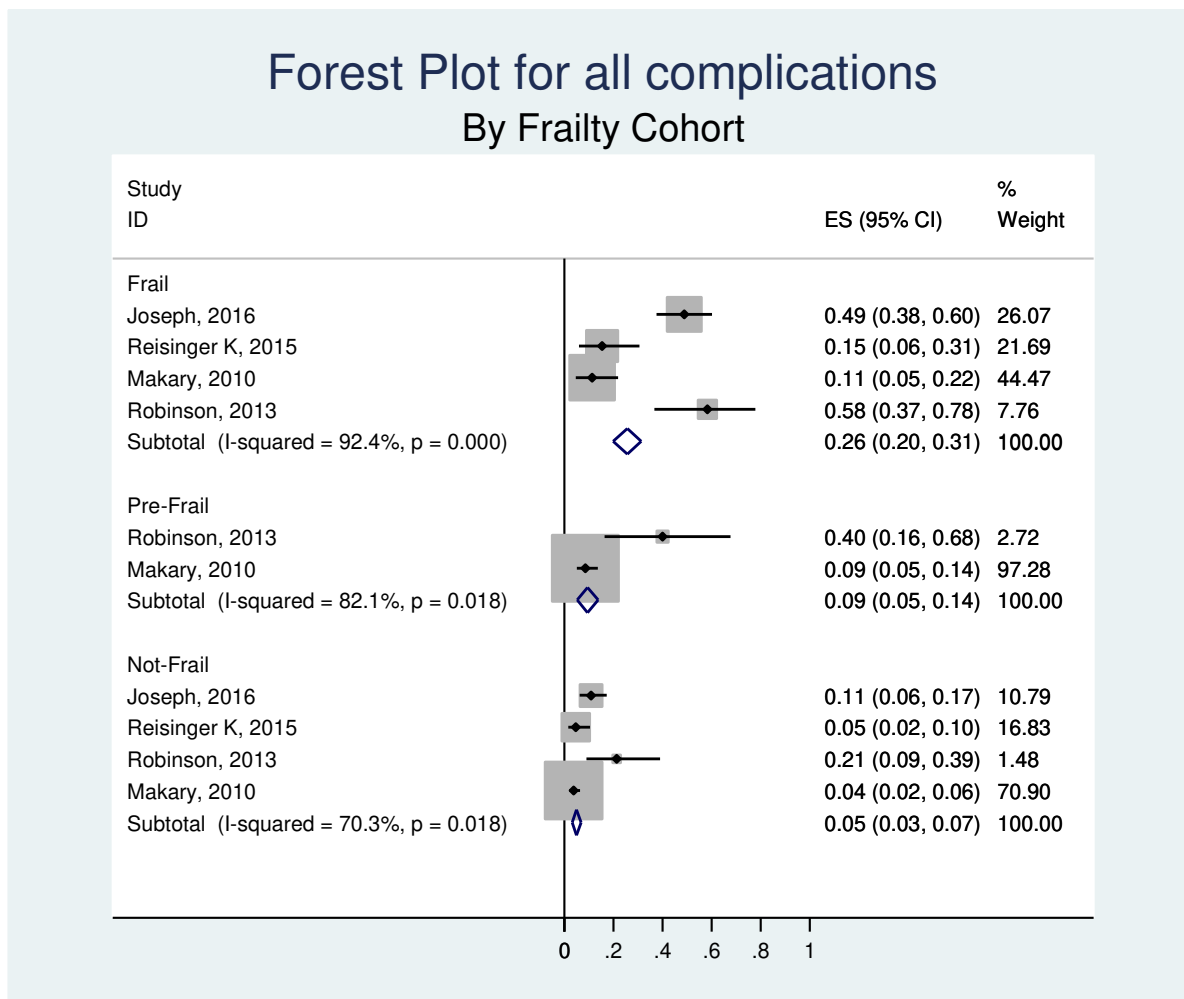


Figure 4 – The proportion of patients who suffer complications following surgery, by frailty and type of procedure (elective or emergency)



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