28 Perioperative cardiac arrest in the older frailer patient


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Key findings

- In the Activity Survey, 25.9% (1,676 of 6,466) of patients over 65 years were reported as being frail, with a clinical frailty scale (CFS) score of 5 or more.
- Older patients (> 65, > 75 and > 85 years) accounted for 26.7%, 12.7% and 3.1% of cases, respectively, in the Activity Survey.
- Increasing age and frailty were both associated with more comorbidities and undergoing surgery on a more urgent or emergency basis.
- Except in the terminally ill, increasing frailty was associated with an increased proportion of surgery being complex or major.
- Use of invasive arterial blood pressure (IABP) monitoring increased as frailty increased up to CFS 6 but was lower in those scoring CFS 7 and 8.
- Frail patients had higher rates of intraoperative complications reported in the Activity Survey (CFS 5–9, 8.5%) than non-frail patients (CFS 1–4, 5.2%).
- There were 156 cardiac arrests in patients 65 years or over and with a CFS score of 5 or more. The estimated incidence (95% confidence interval, CI) in this group of cardiac arrest was 0.083% (0.071 – 0.097%; 1 in 1,204 or 8.3 per 10,000) and of death 0.048% (0.04 – 0.061%; 1 in 2,087 or 4.8 per 10,000).
- In patients over 85 years and those with CFS scores of 7–8, the incidences of cardiac arrest and death associated with anaesthesia were very similar to those in patients over 65 years and in those with CFS scores of 5 and above.
- Hip fracture, emergency laparotomy, emergency vascular surgery and endoscopic urological surgery were the most common surgical procedures in older and frailer patients who suffered pier-operative cardiac arrest.
- Care before cardiac arrest was judged good and poor or poor in the majority of reported cases, whereas care during and after the arrest was generally judged to be good.
- Do not attempt cardiopulmonary resuscitation (DNACPR) recommendations were documented in 37 (24%) of 156 cases with documented frailty, with 15% having treatment limitations.

What we already know

The surgical population is ageing faster than the general population (Fowler 2019), and the frailty of the surgical population, both elective and emergency can be expected to increase in coming years (Kingston 2018, ONS 2022).

Frailty is a clinically recognisable state of increased vulnerability resulting from an ageing-associated decline in reserve and function across multiple physiological systems (Xue 2011). While frailty is associated with ageing, not all older people are frail, and younger people can also be frail. Frailty is a syndrome rather than a disease; it includes impaired homeostatic mechanisms but is also associated with poor nutritional status, weight loss and sarcopenia. Frailty is associated with multimorbidity (either may contribute to the other; CPOC 2021a) and cognitive decline, which may be caused by dementia or independent of it (Rockwood 2005). Clinical conditions associated with frailty include falls, deconditioning, malnutrition and delirium (CPOC 2021a).

Physiology and pharmacology are qualitatively and quantitatively different in older people compared with the 'textbook' young adult, and they tolerate surgical stresses less well. Both increasing age and frailty are associated with worse outcomes following surgery in terms of mortality, complications, length of stay and the person's chance of returning to their original residence (Kennedy 2021; Carter 2020).

Older people and those with frailty are more likely to present for emergency surgery than for planned surgery. This association is partly associated with decisions made earlier in the elective pathway (eg choosing not to offer or proceed with surgery) and partly a result of the co-association of age and frailty with urgent surgical conditions such as fragility fracture, vascular disease and cancer.

Surgery in the older or frailer patient may not be intended to be curative. For some conditions, notably fragility hip fracture, surgery is sometimes a means to provide pain relief and potentially enable mobilisation, such that it is the appropriate option even in the setting of a high-risk of mortality.

The Clinical Frailty Scale (CFS) is one method for assessing frailty. It is recommended to be used only for people over 60 years (Rockwood 2005). Frailty is generally a progressive condition, and each single point increase in the CFS is associated with an approximately 20% increased medium-term (70-month) risk of needing institutional care and death (Rockwood 2005).

The involvement of orthogeriatricians is common in the perioperative management of patient with fragility fracture but less so in other surgical settings.

The 2023 eighth report of the National Emergency Laparotomy Audit (NELA) reported that approximately one-third of patients undergoing emergency laparotomy are frail, more than half are over 65 years and: *'Frailty doubled the risk of mortality amongst those patients aged 65 and over (13.0% versus 5.9%). However, review by a member of the elderly care team was associated with a significant reduction in mortality (5.9% versus 9.5% amongst non-frail patients, and 13.0% versus 22.3% amongst frail patients)'* (NELA 2023).

The same report recommended that all patients undergoing surgery meeting the NELA criteria should have multidisciplinary input that includes early involvement of geriatrician teams, noting approximately 30% compliance with this standard (NELA 2023). This has been incentivised recently within the NHS in England, with the introduction of a financial incentive linked to the proportion of patients 80 years or over or 65 years or over and frail (CFS score ≥ 5) who receive input by perioperative teams experienced in the management of the older patients (NHSE 2022).

There is evidence that proactive models of care for older people undergoing surgery improve outcomes and are cost effective (Partridge 2017).

The UK Third Sprint National Anaesthesia Project examines frailty and surgery and will report in the near future (HSRC 2023).

What we found

Activity Survey

Older patients (> 65, > 75 and > 85 years) represented 6,466 (27%), 3,081 (13%) and 758 (3.1%) of the 24,172 cases in the Activity Survey. Of 6,466 patients 66 years and over in whom a frailty score was recorded, 1,676 (26%) were frail (CFS score ≥ 5). This equates to approximately 1 in 11 (9%) of all adult, non-obstetric surgical patients being frail.

Frailty score increased with age (Figure 28.1, Table 28.1), with 520 (15%) of patients 66–75 years, 683 (29%) 76–85 years and 473 (62%) of those over 85 years recorded as frail.

The number of recorded comorbidities increased as CFS score increased (Figure 28.2, Table 28.2). The median number of comorbidities was 1 for patients with CFS score of 1 and 3 for those with a CFS score of 5 or above. Of patients scored CFS 1, 28% had no comorbidities, compared with 1–2% of patients graded CFS 7–8; no patient graded CFS 1 had five or more comorbidities whereas 24% graded CFS 7–8 did. The number of comorbidities also increased with age (Figure 28.3, Table 28.3). The median number of comorbidities for patients aged 56–65 years was one, and for those over 85 years was three. Twelve percent of patients aged 56–65 years had no comorbidities compared with 4% of those over 85 years; 2.9% of patients 56–65 years had five or more comorbidities, whereas 16% of those over 85 years did.

Figure 28.1 NAP7 Activity Survey Clinical Frailty Scale (CFS) score distribution by age in those over 65 years. CFS Scale: 1 ■, 2 ■, 3 ■, 4 ■, 5 ■, 6 ■, 7 ■, 8 ■, 9 ■, Unknown ■.

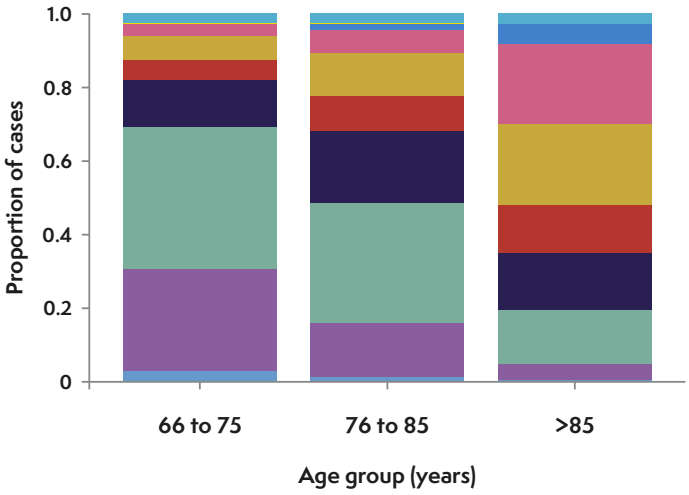
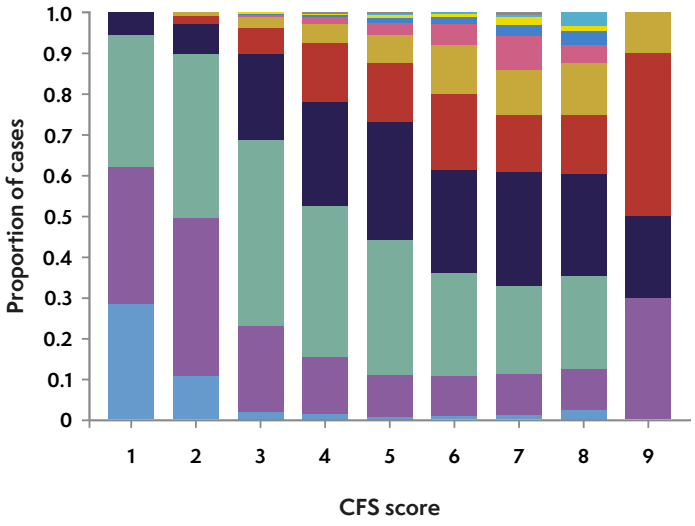


Table 28.1 NAP7 Activity Survey: Clinical Frailty Scale (CFS) score distribution by age in those over 65 years

CFS	Age (years), *n* (%)			Total, *n* (%)
	66–75	76–85	Over 85	
1	99 (3)	22 (1)	3 (0)	124 (2)
2	928 (27)	345 (15)	32 (4)	1305 (20)
3	1311 (39)	756 (33)	111 (15)	2178 (34)
4	436 (13)	459 (20)	118 (16)	1013 (16)
5	185 (5)	221 (10)	99 (13)	505 (8)
6	219 (6)	266 (11)	167 (22)	652 (10)
7	105 (3)	151 (7)	165 (22)	421 (7)
8	8 (0)	38 (2)	42 (6)	88 (1)
9	3 (0)	7 (0)	0 (0)	10 (0)
Unknown	91 (3)	58 (2)	21 (3)	170 (3)
Total	3385 (100)	2323 (100)	758 (100)	6466 (100)

Figure 28.2 NAP7 Activity Survey rate of comorbidity by Clinical Frailty Scale score in patients over 65 years. Number of comorbidites recorded: 0 ■, 1 ■, 2 ■, 3 ■, 4 ■, 5 ■, 6 ■, 7 ■, 8 ■, 9 ■, Unknown ■.



The most prevalent comorbidities (Table 28.4) reported were:

- Hypertension (57% of those 56–65 years and 73% of those over 85 years).
- Atrial fibrillation (4% of those 56–65 years and 29% of those over 85 years).
- Cerebrovascular disease (3% of those 56–65 years and 18% of those over 85 years).
- Moderate respiratory disease (14% of those 56–65 years and 20% of those over 85 years).
- Dementia (0% of those 56–65 years and 21% of those over 85 years).
- Chronic kidney disease stage 3–4 (3% of those 56–65 years and 24% of those over 85 years).
- Diabetes mellitus (15% of those 56–65 years and 14% of those over 85 years).

Table 28.2 NAP7 Activity Survey: reported comorbidities by Clinical Frailty Scale (CFS) score in patients over 65 years

CFS	Reported comorbidities, *n* (%)												
	0	1	2	3	4	5	6	7	8	9	10	11	All patients
1	35 (28)	42 (34)	40 (32)	7 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	124 (100)
2	138 (11)	506 (39)	527 (40)	98 (8)	27 (2)	9 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1305 (100)
3	48 (2)	459 (21)	992 (46)	463 (21)	144 (7)	52 (2)	14 (1)	4 (0)	2 (0)	0 (0)	0 (0)	0 (0)	2178 (100)
4	17 (2)	141 (14)	378 (37)	256 (25)	149 (15)	46 (5)	17 (2)	5 (0)	3 (0)	0 (0)	1 (0)	0 (0)	1013 (100)
5	2 (0)	53 (10)	168 (33)	147 (29)	72 (14)	34 (7)	16 (3)	6 (1)	4 (1)	2 (0)	1 (0)	0 (0)	505 (100)
6	5 (1)	65 (10)	163 (25)	166 (25)	123 (19)	78 (12)	33 (5)	11 (2)	6 (1)	2 (0)	0 (0)	0 (0)	652 (100)
7	5 (1)	42 (10)	91 (22)	118 (28)	59 (14)	47 (11)	35 (8)	11 (3)	8 (2)	0 (0)	3 (1)	2 (0)	421 (100)
8	2 (2)	9 (10)	20 (23)	22 (25)	13 (15)	11 (13)	4 (5)	3 (3)	1 (1)	3 (3)	0 (0)	0 (0)	88 (100)
9	0 (0)	3 (30)	0 (0)	2 (20)	4 (40)	1 (10)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	10 (100)
Unknown	132 (78)	7 (4)	16 (9)	8 (5)	5 (3)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	170 (100)
Total	384 (6)	1327 (21)	2395 (37)	1287 (20)	596 (9)	280 (4)	119 (2)	40 (1)	24 (0)	7 (0)	5 (0)	2 (0)	6466 (100)

Figure 28.3 NAP7 Activity Survey and number of comorbidities by age (years). Number of comorbidities reported: 0 ■, 1 ■, 2 ■, 3 ■, 4 ■, 5 ■, 6 ■, 7 ■, 8 ■, 9 ■, 10 ■, 11 ■.

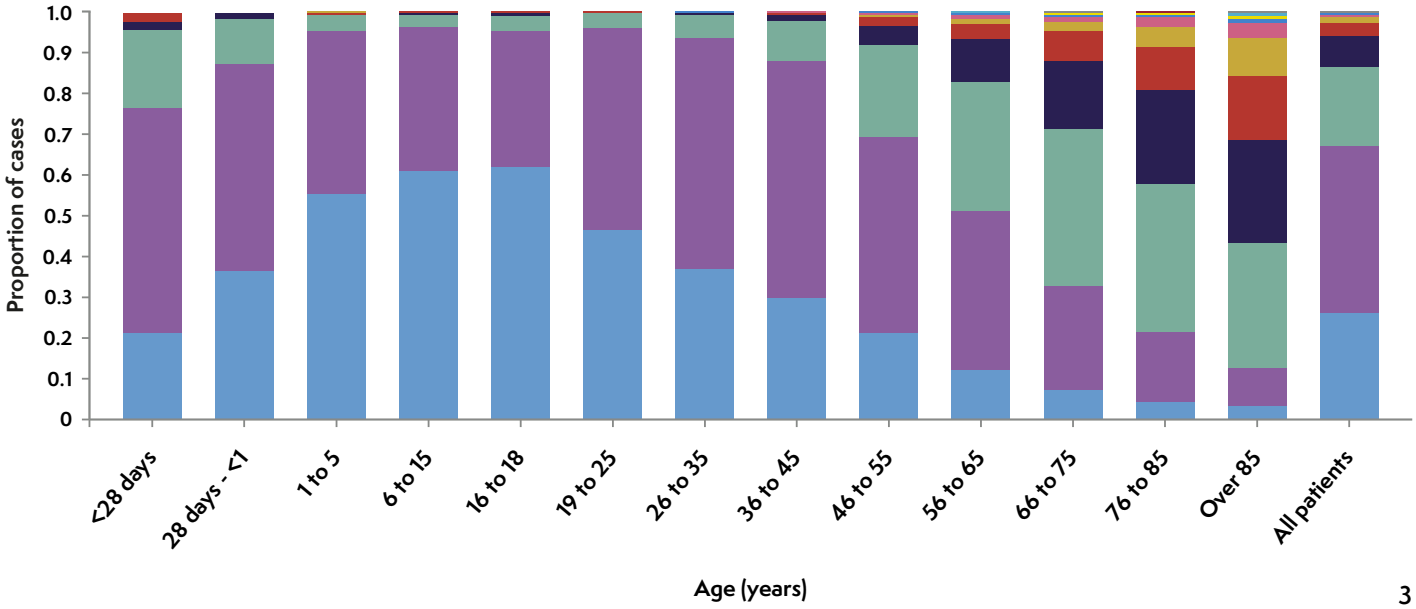


Table 28.3 NAP7 Activity Survey: number of comorbidities by age

Age (years)	Comorbidities, *n* (%)												
	0	1	2	3	4	5	6	7	8	9	10	11	Total
66–75	253 (7)	856 (25)	1315 (39)	562 (17)	243 (7)	86 (3)	37 (1)	16 (0)	11 (0)	2 (0)	3 (0)	1 (0)	3385 (100)
76–85	104 (4)	401 (17)	847 (36)	533 (23)	236 (10)	121 (5)	56 (2)	14 (1)	8 (0)	1 (0)	2 (0)	0 (0)	2323 (100)
> 85	27 (4)	70 (9)	233 (31)	192 (25)	117 (15)	73 (10)	26 (3)	10 (1)	5 (1)	4 (1)	0 (0)	1 (0)	758 (100)
Total	384 (6)	1327 (21)	2395 (37)	1287 (20)	596 (9)	280 (4)	119 (2)	40 (1)	24 (0)	7 (0)	5 (0)	2 (0)	6466 (100)

Table 28.4 NAP7 Activity Survey: rates of individual comorbidities by age. Includes patients aged 19 years and older, with obstetric patients excluded (*n* = 17,567 at risk). CVA, cardiovascular accident; eGFR, estimated glomerular filtration rate; SVT, supraventricular tachycardia; TIA, transient ischaemic attack; VT, ventricular tachycardia. Number (%).

Comorbidity	Age group (years)				
	19–55, *n* (%)	56–65, *n* (%)	66–75, *n* (%)	76–85, *n* (%)	> 85, *n* (%)
Cardiovascular					
Hypertension	890 (11)	1298 (41)	1921 (57)	1514 (57)	550 (73)
Peripheral vascular disease	73 (1)	117 (4)	194 (6)	179 (8)	60 (8)
Cerebrovascular disease (TIA or CVA)	67 (1)	104 (3)	236 (7)	245 (11)	135 (18)
Angina (at rest or mild exertion)	39 (0)	95 (3)	153 (5)	121 (5)	50 (7)
Myocardial infarction or acute coronary syndrome:					
Within 3 months	14 (0)	25 (1)	22 (1)	17 (1)	4 (1)
Older than 3 months	55 (1)	129 (4)	215 (6)	201 (9)	88 (12)
Atrial fibrillation	58 (1)	140 (4)	300 (9)	388 (17)	222 (29)
Any other arrhythmia (eg SVT, VT) at start of anaesthesia care	38 (0)	37 (1)	53 (2)	44 (2)	17 (2)
Severe aortic stenosis	10 (0)	9 (0)	27 (1)	31 (1)	23 (3)
Any other valvular disease	40 (1)	48 (2)	86 (3)	133 (6)	58 (8)
Congestive heart failure	21 (0)	34 (1)	75 (2)	76 (3)	46 (6)
Permanent pacemaker	14 (0)	26 (1)	62 (2)	71 (3)	44 (6)
Implantable cardioverter defibrillator	11 (0)	12 (0)	22 (1)	7 (0)	5 (1)
Grown-up congenital heart disease	42 (1)	6 (0)	7 (0)	2 (0)	0 (0)
Non-cardiovascular					
Respiratory disease:					
Moderate	437 (6)	44 (14)	614 (18)	464 (20)	153 (20)
Severe	50 (1)	29 (1)	52 (2)	40 (2)	7 (1)
Dementia	4 (0)	14 (0)	51 (2)	149 (6)	162 (21)
Diabetes:					
Type 1	94 (1)	40 (1)	21 (1)	19 (1)	7 (1)
Type 2 (medicated, not on insulin)	290 (4)	339 (11)	426 (13)	319 (14)	86 (11)
Type 2 (on insulin)	76 (1)	90 (3)	101 (3)	58 (2)	15 (2)
Chronic kidney disease:					
3 or 4 (eGFR 15–29)	77 (1)	105 (3)	244 (7)	332 (14)	185 (24)
5 (dialysis dependent)	62 (1)	41 (1)	30 (1)	17 (1)	2 (0)
Liver disease:					
Mild	65 (1)	52 (2)	39 (1)	334 (1)	3 (0)
Moderate or severe	48 (1)	22 (1)	15 (0)	13 (1)	0 (0)
Active gastrointestinal bleeding	28 (0)	13 (0)	10 (0)	13 (1)	2 (0)
Solid-organ tumour within past 5 years:					
Localised	160 (2)	209 (7)	231 (7)	166 (7)	46 (6)
Metastatic	63 (1)	61 (2)	73 (2)	43 (2)	7 (1)
Lymphoma	15 (0)	11 (0)	24 (1)	16 (1)	7 (1)
Leukaemia	8 (0)	6 (0)	5 (0)	13 (1)	5 (1)
Connective tissue disease	84 (1)	53 (2)	72 (2)	41 (2)	11 (1)
Peptic ulcer disease	41 (1)	46 (1)	49 (1)	37 (2)	9 (1)
Hemiplegia	17 (0)	14 (0)	8 (0)	2 (0)	3 (0)
Patients at risk	7096	3197	3384	2323	757

All other comorbidities (excluding obesity) occurred in less than 10% of each age group.

The proportion of surgery undertaken on a non-elective basis had peaks in very young children, young adults and the elderly (< 1 year, 19–25 years, > 85 years; Figure 28.4, Table 28.5). In patients 66–85 years, 82% of care was planned (day case or expedited, 4,694 of 5,707). In patients over 85 years, 65% of care was planned (494 of 757).

Figure 28.4 NAP7 Activity Survey urgency of surgery by age (years). Urgency of surgery: Elective (day case) ■, Elective (planned inpatient stay) ■, Expedited ■, Urgent ■, Immediate ■, Not recorded ■.

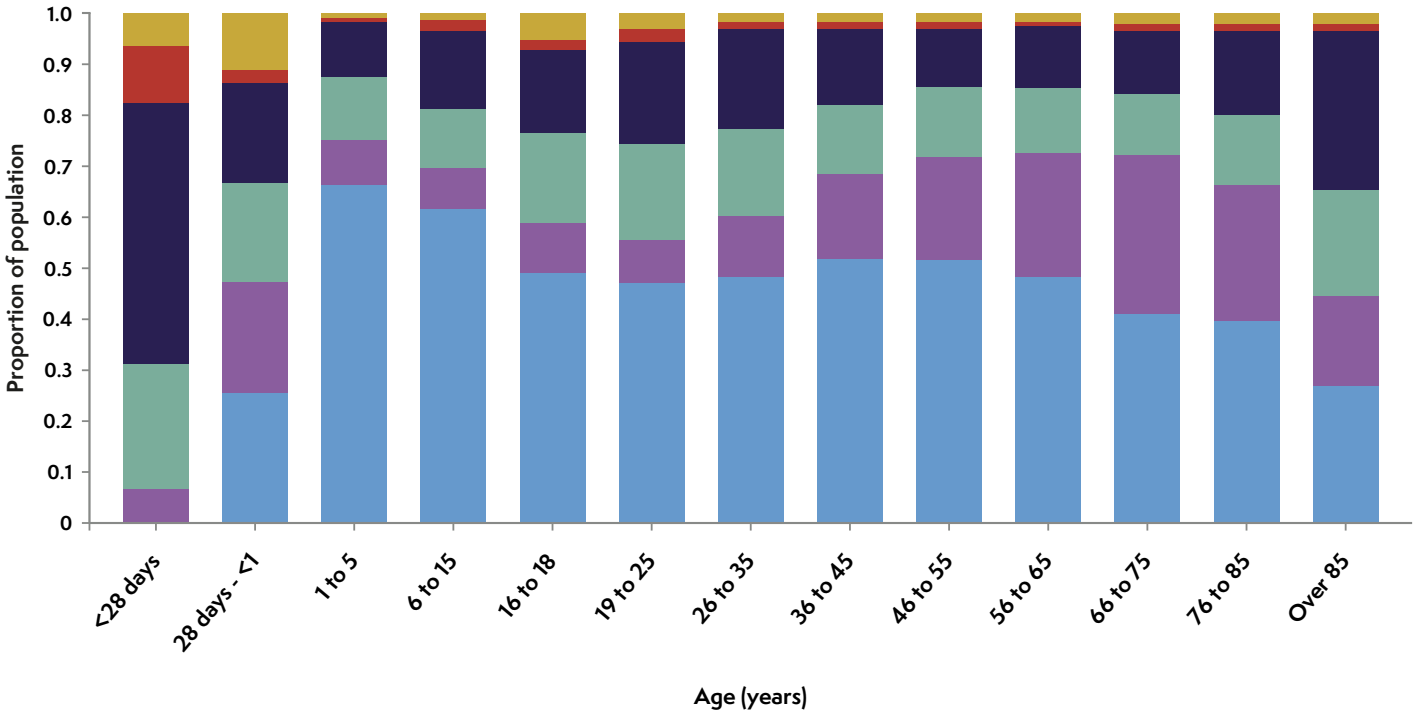


Table 28.5 NAP7 Activity Survey: urgency of surgery by age (excluding obstetric cases)

Age (years)	Elective, *n* (%)		Expedited, *n* (%)	Urgent, *n* (%)	Immediate, *n* (%)	Not recorded, *n* (%)	Total, *n* (%)
	Day case	Planned inpatient					
< 28 days	0 (0)	3 (7)	11 (24)	23 (51)	5 (11)	3 (7)	45 (100)
28 days to 1	50 (25)	43 (22)	38 (19)	39 (20)	5 (3)	22 (11)	197 (100)
1–5	683 (66)	94 (9)	127 (12)	111 (11)	7 (1)	12 (1)	1034 (100)
6–15	1040 (61)	138 (8)	195 (11)	264 (16)	35 (2)	24 (1)	1696 (100)
16–18	224 (49)	46 (10)	79 (17)	74 (16)	10 (2)	24 (5)	457 (100)
19–25	496 (47)	89 (8)	199 (19)	212 (20)	24 (2)	34 (3)	1054 (100)
26–35	989 (48)	240 (12)	351 (17)	400 (20)	25 (1)	39 (2)	2044 (100)
36–45	1114 (52)	356 (17)	291 (14)	319 (15)	31 (1)	41 (2)	2152 (100)
46–55	1369 (52)	534 (20)	367 (14)	302 (11)	30 (1)	54 (2)	2656 (100)
56–65	1542 (48)	772 (24)	415 (13)	377 (12)	37 (1)	54 (2)	3197 (100)
66–75	1392 (41)	1049 (31)	399 (12)	424 (13)	37 (1)	83 (2)	3384 (100)
76–85	919 (40)	617 (27)	318 (14)	390 (17)	28 (1)	51 (2)	2323 (100)
> 85	205 (27)	132 (17)	157 (21)	236 (31)	9 (1)	18 (2)	757 (100)
Total	10023 (48)	4113 (20)	2947 (14)	3171 (15)	283 (1)	459 (2)	20996 (100)

The proportion of non-elective and emergency surgery rose across with increasing CFS scores (Figure 28.5, Table 28.6). Elective surgery reduced from 85% in patients who were CFS 1 to 11% in those who were CFS 8 and conversely, emergency surgery (National Confidential Enquiry into Patient Outcome and Death urgent or immediate) from 9% in patients who were CFS 1 to 55% in those graded CFS 8.

The complexity of surgery also increased with increasing frailty (Table 28.7) with more frail patients, with the exception of patients graded CFS 9, having a higher proportion of complex or major surgery (CFS 1–4 37% vs CFS 5–6 43% and CFS 7–8 50%).

Figure 28.5 NAP7 Activity Survey urgency of surgery by degree of frailty. CFS, Clinical Frailty Scale. Elective (day case) ■, Elective (planned inpatient stay) ■, Expedited ■, Urgent ■, Immediate ■, Not recorded ■.

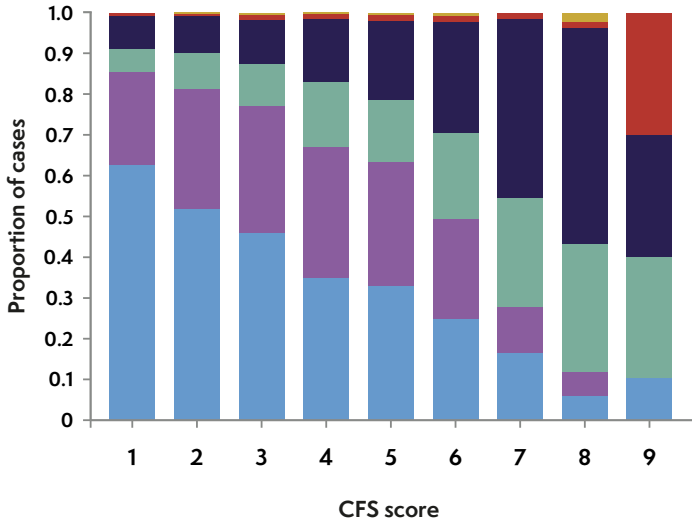


Table 28.6 NAP7 Activity Survey: urgency of surgery by Clinical Frailty Scale (CFS) score in patients over 65 years

CFS	Elective, *n* (%)		Expedited, *n* (%)	Urgent, *n* (%)	Immediate, *n* (%)	Not recorded, *n* (%)	Total, *n* (%)
	Day case	Planned inpatient					
1	78 (63)	28 (23)	7 (6)	10 (8)	1 (1)	0 (0)	124 (100)
2	676 (52)	384 (29)	116 (9)	117 (9)	9 (1)	3 (0)	1305 (100)
3	1002 (46)	683 (31)	221 (10)	242 (11)	23 (1)	7 (0)	2178 (100)
4	353 (35)	327 (32)	162 (16)	155 (15)	14 (1)	2 (0)	1013 (100)
5	166 (33)	154 (30)	77 (15)	98 (19)	7 (1)	3 (1)	505 (100)
6	160 (25)	162 (25)	138 (21)	178 (27)	9 (1)	5 (1)	652 (100)
7	69 (16)	48 (11)	113 (27)	185 (44)	6 (1)	0 (0)	421 (100)
8	5 (6)	5 (6)	28 (32)	47 (53)	1 (1)	2 (2)	88 (100)
9	1 (10)	0 (0)	3 (30)	3 (30)	3 (30)	0 (0)	10 (100)
Unknown	7 (4)	7 (4)	9 (5)	15 (9)	1 (1)	131 (77)	170 (100)
Total	2517 (39)	1798 (28)	874 (14)	1050 (16)	74 (1)	153 (2)	6646 (100)

Table 28.7 NAP7 Activity Survey: grade of surgery by Clinical Frailty Scale (CFS) score in patients over 65 years

CFS	Surgical severity, *n* (%)				
	Minor	Intermediate	Major or complex	Unknown	Total
1	38 (31)	46 (37)	39 (31)	1 (1)	124 (100)
2	293 (22)	535 (41)	466 (36)	11 (1)	1305 (100)
3	425 (20)	829 (38)	892 (41)	32 (1)	2178 (100)
4	212 (21)	311 (31)	470 (46)	20 (2)	1013 (100)
5	89 (18)	181 (36)	216 (43)	19 (4)	505 (100)
6	118 (18)	224 (34)	297 (46)	13 (2)	652 (100)
7	81 (19)	111 (26)	217 (52)	12 (3)	421 (100)
8	11 (13)	23 (26)	52 (59)	2 (2)	88 (100)
9	1 (10)	4 (40)	5 (50)	0 (0)	10 (100)
Unknown	6 (4)	8 (5)	20 (12)	136 (80)	170 (100)
Total	1274 (20)	2272 (35)	2674 (41)	116 (2)	6466 (100)

In general terms, as frailty increased so did the extent of monitoring up to CFS 4. The highest rate for all monitors was in those with CFS 6. For those scoring CFS 7–8, rates of invasive blood pressure, neuromuscular, processed EEG and continuous temperature monitoring were all lower than for those with CFS 6 (Figure 28.6, Table 28.8).

Figure 28.6 NAP7 Activity Survey frequency of monitor use by Clinical Frailty Scale (CFS). Only CFS 1 to 8 shown 1 ■, 2 ■, 3 ■, 4 ■, 5 ■, 6 ■, 7 ■, 8 ■. BIS, bispectral index; EEG, electroencephalogram.

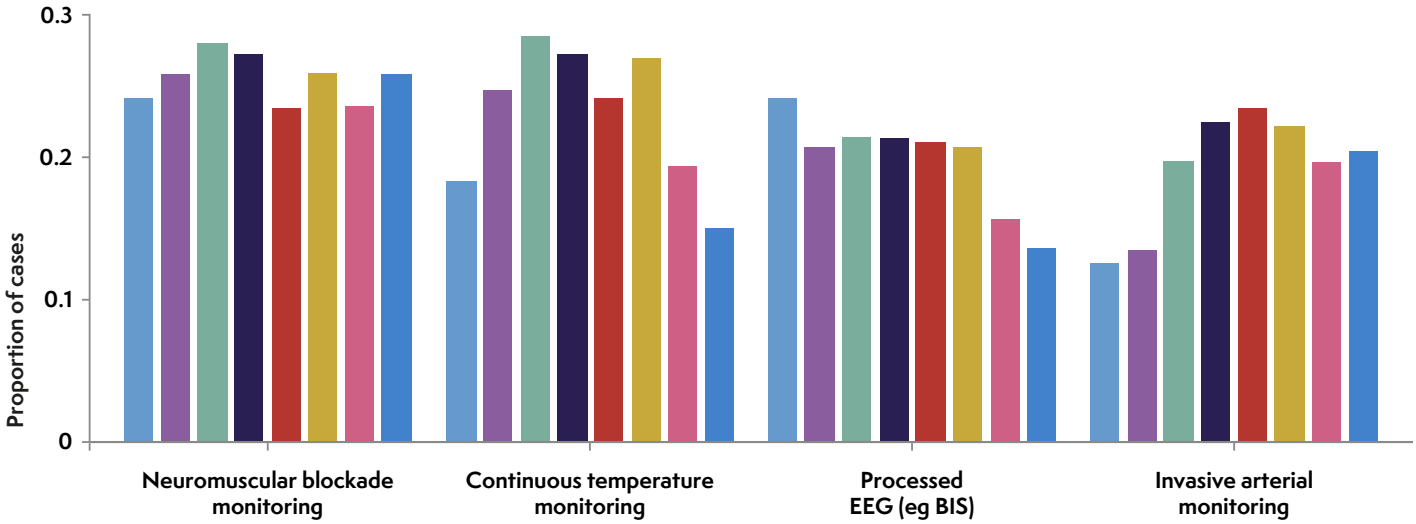


Table 28.8 NAP7 Activity Survey: use of monitoring by Clinical Frailty Scale (CFS) score in patients over 65 years. Values are number and percentage of patients monitored by each modality in each group. BIS, bispectral index; EEG, electroencephalogram; NIRS, near-infrared spectroscopy.

Monitor	Clinical Frailty Scale Score, *n* (%)										
	0	1	2	3	4	5	6	7	8	9	Unknown
Neuromuscular blockade monitoring	25 (20)	281 (22)	510 (23)	231 (23)	99(20)	141 (22)	83 (20)	19 (22)	2 (20)	6 (4)	124 (100)
Continuous temperature monitoring	19 (15)	269 (21)	519 (24)	231 (23)	102 (20)	147 (23)	68 (16)	11 (13)	1 (10)	12 (7)	1305 (100)
Processed EEG (eg BIS)	25 (20)	226 (17)	390 (18)	181 (18)	89 (18)	113 (17)	55 (13)	10 (11)	1 (10)	7 (4)	2178 (100)
Invasive arterial monitoring	13 (10)	146 (11)	359 (16)	190 (19)	99 (20)	121 (19)	69 (16)	15 (17)	5 (50)	13 (8)	1013 (100)
Central venous pressure	3 (2)	41 (3)	112 (5)	44 (4)	27 (5)	24 (4)	17 (4)	3 (3)	2 (20)	6 (4)	505 (100)
Point of care coagulation	2 (2)	15 (1)	63 (3)	23 (2)	16 (3)	18 (3)	5 (1)	1 (1)	0 (0)	3 (2)	652 (100)
Cardiac output	2 (2)	17 (1)	44 (2)	20 (2)	10 (2)	8 (1)	7 (2)	2 (2)	0 (0)	0 (0)	421 (100)
Echocardiography (transthoracic or trans-oesophageal)	2 (2)	8 (1)	46 (2)	15 (1)	9 (2)	7 (1)	5 (1)	0 (0)	0 (0)	1 (1)	88 (100)
NIRS	0 (0)	5 (0)	8 (0)	5 (0)	2 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	10 (100)
Patients in group	124	1305	2178	1013	505	652	421	88	10	170	170 (100)

The reported rate of all complications increased with CFS (Figure 28.7, Table 28.9) and with age (Table 28.10).

Significantly older and frailer patients

A summary of data from significantly older (> 85 years) and severely frail (CFS 7–8) patients can be found in Appendices 28.1 and 28.2.

Figure 28.7 NAP7 Activity Survey rates of complications by Clinical Frailty Scale (CFS) score. Error bars represent 95% confidence interval.

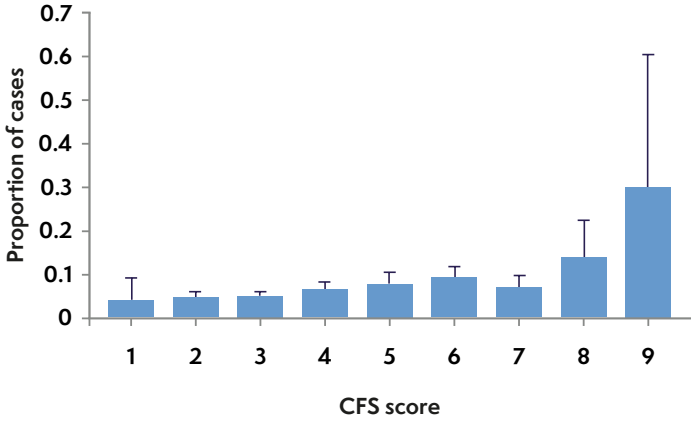


Table 28.9 NAP7 Activity Survey: intraoperative complications by Clinical Frailty Scale (CFS) score in patients over 65 years

CFS score	Cases with one or more complications		Patients at risk
	(*n*)	(%)	(*n*)
1	5	4.0	124
2	60	4.6	1305
3	109	5.0	2178
4	65	6.4	1013
5	39	7.7	505
6	60	9.2	652
7	29	6.9	421
8	12	13.6	88
9	3	30.0	10
Unknown	5	3.8	130
Total	387	6.0	6466

Table 28.10 NAP7 Activity Survey: intraoperative complications by age

Age (years)	Patients with one or more complications		Patients at risk
	(*n*)	(%)	(*n*)
19–25	50	4.7	1054
26–35	96	4.7	2044
36–45	121	5.6	2152
46–55	142	5.3	2656
56–65	190	5.9	3197
66–75	203	6.0	3384
76–85	141	6.1	2323
Over 85	43	5.7	757
Total	986	5.6	17567

Cardiac arrest case reports

To describe the impact of older age and frailty on perioperative cardiac arrest, we explored a cohort of 156 patients who were both over 65 years of age and reported to be CFS 5 or above, hereafter referred to as 'older-frailer'. This grouping is in line with other definitions of older and frailer cohorts (CPOC 2021a, NELA 2023). We have considered significantly older (over 85 years) and severely frail (CFS 7–8) patients as separate cohorts and summary results are in Appendices 28.1 and 28.2.

Patient characteristics compared with the Activity Survey

Patients who had a cardiac arrest were older than patients in the Activity Survey (over 65 years, 48% vs 27% for all patients, and 58% vs 36% if excluding children and obstetric patients; Figure 28.8, Table 28.11). The relative risk of cardiac arrest in those over 65 years is approximately 1.6–1.8 (depending on the comparative cohort used). More patients who had a cardiac arrest were frail than in the Activity Survey (20% vs 8.1%).

Figure 28.8 NAP7 Activity Survey and case registry: age distribution of adult cardiac arrest cases (*n* = 717) and Activity Survey patients (adult, non-obstetric; *n* = 17,567). Cases ■, Activity ■.

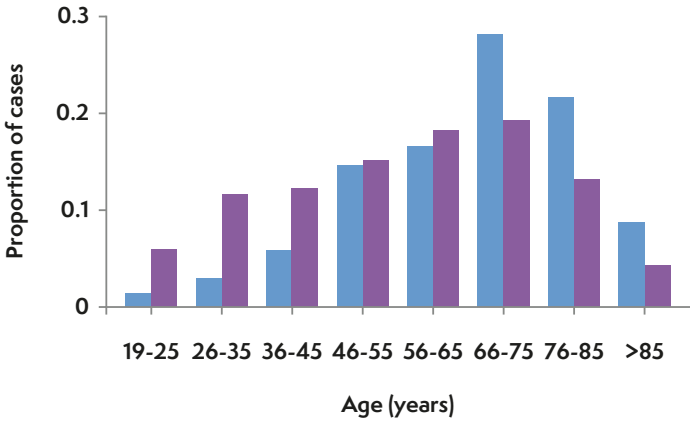


Table 28.11 Ages of NAP7 Activity Survey (adult, non-obstetric) and adult cardiac arrest cases

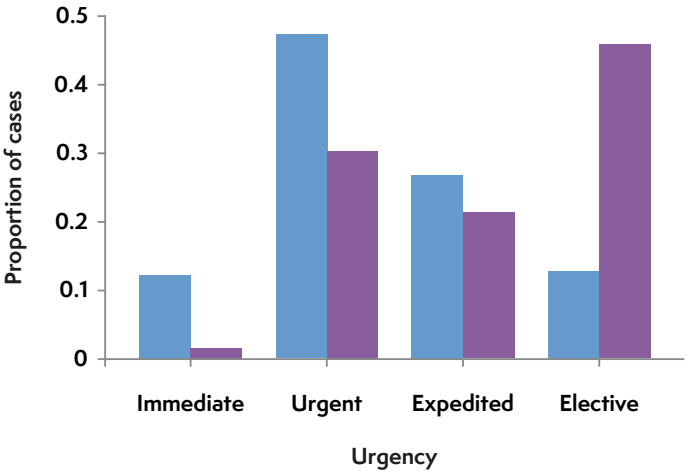
Age (years)	Activity Survey (*n* = 17,567)		Cases (*n* = 717)	
	(*n*)	(%)	(*n*)	(%)
19–25	1054	6.0	10	1.4
26–35	2044	12	21	2.9
36–45	2152	12	42	5.9
46–55	2656	15	105	15
56–65	3197	18	119	17
66–75	3384	19	202	28
76–85	2323	13	155	22
> 85	757	4.3	62	8.7
Missing	0	0	1	0.1

Among 156 older-frailer who had a cardiac arrest, compared with the same cohort in the Activity Survey (*n* = 1676), a slightly higher proportion were male (51% vs 46%), fewer were white (90% vs 95%), more were ASA 4–5 (50% vs 25%). The distribution of body mass indices (BMI) was similar (9% underweight vs 8.4%, 24% obese vs 29%). In patients in the older frailer group who had cardiac arrest, the degree of frailty was modestly decreased relative to the Activity Survey cohort (Table 28.12). They were more likely to be undergoing non-elective surgery (86% vs 51%; Figure 28.9, Table 28.13) and major or complex surgery (65% vs 47%).

Table 28.12 Characteristics of older frail patients (age >65 years and CFS score 5 or above) in Activity Survey, older frailer registry cases and all other registry cases

Characteristic	Older frailer Activity Survey cases (*n* = 1,676), *n* (%)	Older frailer registry cases (*n* = 156), *n* (%)	Other registry cases (*n* = 725), *n* (%)
Sex:			
Male	771 (46)	79 (51)	419 (58)
Female	905 (54)	77 (49)	305 (42)
Ethnicity:			
White	1,600 (95)	141 (90)	586 (81)
Mixed/multiple ethnic groups	3 (0.2)	0 (0)	3 (0.4)
Asian/Asian British	34 (2.0)	7 (4.5)	61 (8.4)
Black/African/Caribbean/black British	16 (1.0)	0 (0)	22 (3.0)
Other ethnic group	2 (0.1)	1 (0.6)	4 (0.6)
Not Known	21 (1.3)	7 (4.5)	49 (6.8)
Body mass index (kg m^{-2}):			
< 18.5 (underweight)	141 (8.4)	14 (9.0)	6 (0.8)
18.5–24.9 (normal)	653 (39)	58 (37)	175 (24)
25.0–29.9 (overweight)	356 (21)	34 (22)	162 (22)
30.0–34.9 (obese 1)	270 (16)	21 (13)	103 (14)
35.0–39.9 (obese 2)	151 (9.0)	7 (4.5)	54 (7.4)
40.0–49.9 (obese 3)	53 (3.2)	6 (3.8)	27 (3.7)
50.0–59.9	9 (0.5)	2 (1.3)	3 (0.4)
≥ 60	9 (0.5)	1 (0.6)	2 (0.3)
Unknown	34 (2.0)	13 (8.3)	193 (27)
ASA score:			
1	0 (0)	0 (0)	62 (8.6)
2	158 (9.4)	7 (4.5)	166 (23)
3	1,105 (66)	71 (46)	253 (35)
4	399 (24)	73 (47)	182 (25)
5	11 (0.7)	5 (3.2)	62 (8.6)
Unknown	3 (0.2)	0	0
Clinical Frailty Scale:			
1–3 (not frail)	NA	NA	359 (50)
4 (vulnerable)	NA	NA	115 (16)
5	500 (30)	48 (31)	7 (1.0)
6	625 (38)	67 (43)	15 (2.1)
7	431 (26)	28 (18)	10 (1.4)
8	92(6)	13 (8)	1 (0.1)
Not applicable/not known			218 (30)
Modified Rankin Scale:			
0	NA	12 (7.7)	218 (30)
1	NA	15 (9.6)	157 (22)
2	NA	26 (17)	82 (11)
3	NA	57 (37)	42 (5.8)
4	NA	29 (19)	11 (1.5)
5	NA	9 (5.8)	4 (0.6)
NA	NA	1 (0.6)	135 (19)
Unknown	NA	7 (4.5)	76 (10)

Figure 28.9 NAP7 Activity Survey and case registry: procedure urgency in older-frailer patients in the Activity Survey ■ and cardiac arrest reports ■.



group in the Activity Survey, less likely to be receiving neuraxial anaesthesia (22% vs 26%) and more likely to be receiving general anaesthesia (71% vs 59%; Table 28.14).

Comparison with other cardiac arrest cases

Older-frailer patients who had a cardiac arrest were, compared with other patients reported to NAP7, more often female (49% vs 42%) and white (90% vs 81%), had a higher ASA class (ASA 3–5, 95% vs 68%; Table 28.13) and a lower BMI (9% underweight vs 0.8%, 26% obese vs 35%; Table 28.12), were more likely to be undergoing urgent or expedited surgery (47% and 27% vs 25% and 14%; Table 28.13).

Do not attempt CPR recommendations were more common in the older-frailer cases (37/156 (24%)) than other cases (17/725 (2%)) with 24/156 (15%) and 13/725 (2%) having treatment

Table 28.13 Characteristics of older frail patients (age >65 years and Clinical Frailty Scale score 5 or above) in Activity Survey, older frailer registry cases and all other registry cases

Surgical characteristic	Older frailer Activity Survey cases (*n* = 1,676), *n* (%)	Older frailer registry cases (*n* = 156), *n* (%)	Other registry cases (*n* = 725), *n* (%)
Urgency of surgery:			
Immediate	26 (2%)	19 (12%)	152 (21%)
Urgent	511 (31%)	74 (47%)	182 (25%)
Expedited	359 (22%)	42 (27%)	101 (14%)
Procedural specialty:			
Orthopaedics: trauma	520 (31%)	61 (39%)	44 (6%)
Abdominal: lower gastrointestinal	64 (4%)	18 (12%)	67 (9%)
Cardiology: interventional	23 (1%)	17 (11%)	36 (5%)
Vascular	99 (6%)	14 (9%)	55 (8%)
Urology	187 (11%)	8 (5%)	33 (5%)
Gastroenterology	15 (1%)	6 (4%)	11 (2%)
General Surgery	91 (5%)	6 (4%)	45 (6%)
Abdominal: upper gastrointestinal	23 (1%)	3 (2%)	38 (5%)
Cardiac surgery	17 (1%)	3 (2%)	77 (11%)
Cardiology: electrophysiology	9 (1%)	3 (2%)	8 (1%)
Neurosurgery	24 (1%)	3 (2%)	21 (3%)

The five most prevalent surgical specialties of older-frailer patients who had a cardiac arrest were orthopaedic trauma (61 of 156 cases, 39%), lower gastrointestinal (18 cases, 12%), interventional cardiology (17 cases, 11%), vascular (14 cases, 9%) and urology (8 cases, 5%). The top four of these specialties were all overrepresented compared with the same cohort in the Activity Survey (trauma 520/1,676, 31%; lower gastrointestinal 64, 4%; interventional cardiology 23, 1%; vascular 99, 6%; and urology 187 11%; (Figure 28.10, Table 28.13). Older-frailer patients who had a cardiac arrest were, compared with the same

limitations, respectively. In a little over half of cases DNA CPR recommendations were formally suspended at the time of surgery (Table 28.15).

Cardiac arrests occurred modestly more frequently during the day in the older-frailer group than the rest of the cases, with 122/156 (78%) occurring between 09.00 and 21.00 (compared with 505/725 (70%)).

Figure 28.10 NAP7 Activity Survey and case registry: procedure specialty in older-frailer patients (> 65 years and CFS ≥ 5). Cardiac arrest cases *n* = 156. ■, Activity Survey *n* = 1,676 ■. GI, gastrointestinal.

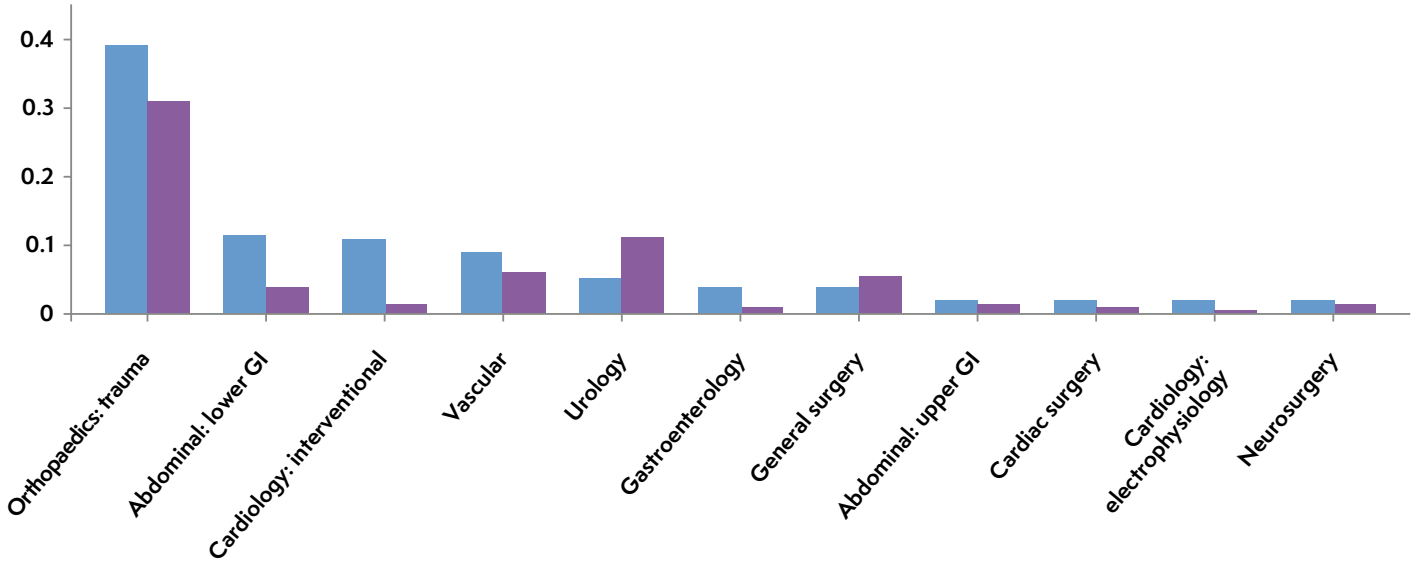


Table 28.14 Anaesthetic type for older frailer patients (> 65 years and CFS ≥ 5) in Activity Survey, older frailer registry cases and all other registry cases

Mode of anaesthesia	Older frailer Activity Survey cases (*n* = 1,676), *n* (%)	Older-frailer patients (*n* = 156), *n* (%)	Other registry cases (*n* = 725), *n* (%)
General	682 (42)	72 (46)	545 (75)
General + neuraxial	48 (3.0)	7 (4.5)	46 (6.3)
General + regional	235 (14)	33 (21)	31 (4.3)
Neuraxial	193 (12)	15 (9.6)	31 (4.3)
Neuraxial + sedation	192 (12)	13 (8.3)	13 (1.8)
Regional	126 (7.8)	1 (0.6)	2 (0.3)
Regional + sedation	38 (2.3)	0 (0)	2 (0.3)
Sedation	80 (4.9)	10 (6.4)	13 (1.8)
IV analgesia only	0 (0)	1 (0.6)	0
Local infiltration	0 (0)	2 (1.3)	0
Monitoring only	29 (1.8)	2 (1.3)	7 (1.0)
Unknown	53 (3.2)	0	0

Table 28.15 Resuscitation characteristics of older-frailer NAP7 cases (aged > 65 years and CFS ≥ 5) compared with other cases

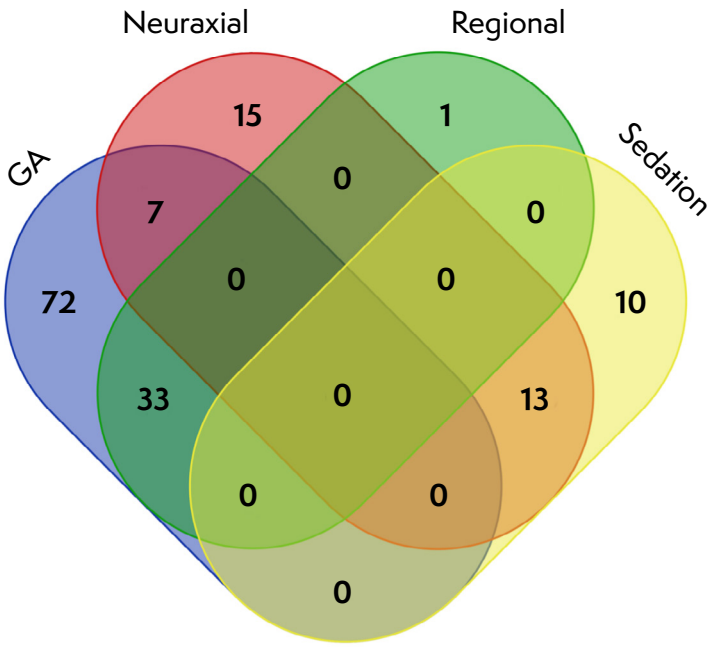
Resuscitation characteristic	Older-frailer (*n* = 156)		Other cases (*n* = 725)	
	n	(%)	*n*	(%)
DNACPR recommendation:				
Yes (all)	37	24	17	2.4
Yes, active at time of arrest	15	9.6	5	0.7
Yes, formal temporary suspension	18	12	7	1.0
Yes, unknown whether suspended	4	2.6	5	0.7
No	116	74	702	97
Unknown	3	1.9	6	0.8
Treatment limitations:				
Yes	24	15	13	1.8
No	118	76	688	95
Unknown	14	9.0	24	3.3
Initial outcome of event:				
Died	52	33	150	21
Died (DNACPR in place)	4	2.6	3	0.4
Not known/ recorded	2	1.3	5	0.7
Survived	98	63	567	78
Hospital outcome:				
Alive	43	28	341	47
Dead	93	60	255	35
Unknown or still admitted	20	13	129	18

Other than a modestly greater proportion of cases occurring in the cardiac catheter lab (10% versus 6%) in the older frailer group, there were no major differences in place of cardiac arrest, with most occurring in theatre, and 16/156 (10%) in the anaesthetic room.

Older-frailer patients who had a cardiac arrest were, compared with the same group in the Activity Survey, less likely receive neuraxial anaesthesia (22% vs 26%) and more likely to receive general anaesthesia (71% vs 59%; Table 28.14).

Mode of anaesthesia for older-frailer patients differed from other patients in the cardiac arrest cohort with less general anaesthesia (67% vs 80%), more neuraxial anaesthesia (22% vs 12%) and more sedation only procedures (6% vs 2%; Table 28.14, Figure 28.11). These differences are driven in part by the surgical characteristics, orthopaedic trauma and cardiology being more common in the older and frailer cases (Table 28.13).

Figure 28.11 NAP7 case registry: modes of anaesthesia in older-frailer patients (*n* = 156)



The perioperative phase in which cardiac arrest occurred did not differ substantially in the older-frailer group compared with others: 30% before surgery started and 26% after surgery had finished. Cardiac arrest during induction, during transfers and in recovery were not notably more common in the older frailer group than in those younger and less frail.

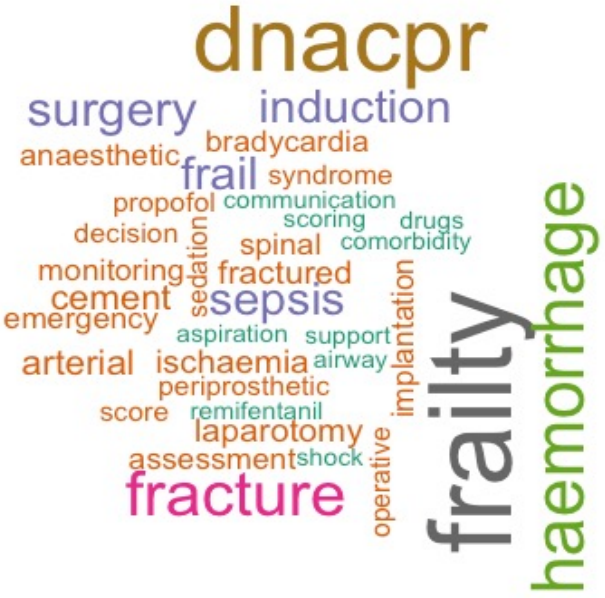
The initial presentation of cardiac arrest was predominantly pulseless electrical activity (PEA; 91/156, 58%), asystole in 28 (18%) and bradycardia in 18 (12%). A shockable rhythm was present in 13/156 (8%) cases. Management of cardiac arrest differed little in this group compared to others. Duration of resuscitation attempts were also broadly similar whether the patient was older-frailer or not (Table 28.16).

Table 28.16 Duration of cardiac arrest in older-frailer NAP7 cases (age > 65 years and CFS ≥ 5) compared with other cases

Duration of resuscitation (minutes)	Older-frailer (*n* = 156)		Other cases (*n* = 725)	
	n	(%)	*n*	(%)
< 10	103	66	486	67
10–20	24	15	92	13
20–30	13	8.3	55	7.6
30–40	3	1.9	26	3.6
40–50	2	1.3	17	2.3
50–60	4	2.6	15	2.1
60–120	2	1.3	13	1.8
> 120	3	1.9	15	2.1
Unknown/missing	2	1.3	6	0.8

In panel judgement of the key causes of cardiac arrest the patient was cited in 142 (91%) of cases, with both anaesthesia and surgery cited in 75 (48%) and organisation or postoperative care in 13 (8%) and 18 (12%) cases, respectively. The patient was cited as the sole key cause in 28 (18%) and anaesthesia and surgery in 8 (5.1%) and 3 (1.9%) cases, respectively. In thematic analysis, both patient and anaesthesia were prominent (Figure 28.12 shows the most frequently used keywords).

Figure 28.12 Keywords on panel review of cases. Increasing size equates to increasing frequency



There were 93 deaths reported out of 156 cardiac arrests in this group. The incidence (95% confidence interval, CI) of cardiac arrest in this group is estimated to be 0.083% (0.071 – 0.097%) (1 in 1204 or 8.3 per 10,000) and of death 0.048% (0.04 – 0.061%) (1 in 2087 or 4.8 per 10,000).

Death at the time of cardiac arrest was more frequent among older-frailer patients (56/156, 36%) compared with other patients reported to NAP7 (153/725, 21%), as was death by the time of reporting (93/156, 60% vs 255/725, 35%; Table 28.15). Of the 74 patients who died in whom the panel was able to make a judgement, the death was judged to be part of an inexorable process in 14 (19%), partially so in 28 (38%) and it was not judged inexorable in 32 (43%). Degree of harm was judged by the panel to be death in 90 (58%) patients, severe harm in 14 (9%) and moderate harm in 52 (33%).

In very old and very frail patients, the incidences of cardiac arrest and death associated with anaesthesia were very similar to this, being generally 5–15% lower.

The leading 'causes' of cardiac arrest identified by the panel were (more than one cause may have been identified):

- Haemorrhage: 25 cases, of which 2 were abdominal aortic aneurysms.
- Drug related (dose or choice of anaesthetic agents): 25 (of which 4 were drug errors/interruptions/omission).
- Septic shock: 16 (with another 6 cases of sepsis).
- Cardiac ischaemia: 22.
- Bone cement implantation syndrome (BCIS): 18.

Ratings of care as judged by the review panel are shown in Table 28.17. The panel judgement of care was lower before cardiac arrest care than during or following cardiac arrest, as was the case throughout NAP7. Compared with the younger, less frail cases, rating of care in older-frailer patients was good before cardiac arrest somewhat less often (36% vs 48%) and overall (45% vs 53%) but other judgements were very similar in both groups.

Table 28.17 Panel ratings of quality of care in cardiac arrest management of older-frailer patients

	Good, *n* (%)	Good and poor, *n* (%)	Poor, *n* (%)	Unclear, *n* (%)
Before cardiac arrest	56 (36)	49 (32)	22 (14)	27 (18)
During cardiac arrest	126 (82)	13 (8.4)	3 (1.9)	12 (7.8)
After cardiac arrest	118 (78)	9 (6.0)	1 (0.7)	23 (15)
Overall	69 (45)	61 (40)	3 (1.9)	21 (14)

The poor/good and poor ratings before cardiac arrest were multifactorial, relating to decision making, discussion of risks/DNACPR, appropriateness of techniques/doses used, and use of monitoring in predictably high-risk cases. Drug dosing was noted as at least a contributory factor in more than 12% of the older-frailer cohort. This included doses of general anaesthetic drugs, local anaesthetic and intrathecal opioids.

The lack or late use of IABP monitoring in this high-risk group was formally documented by the panel in 13 cases. Cardiac arrest occurred in patients both with and without IABP monitoring.

There were three cases where questions were raised about the appropriate seniority of the primary anaesthetist.

A debrief was done or planned in 55% of cases where this was known, somewhat less often than in all cases (61%).

Examples of good care included:

- Prompt initiation of cardiopulmonary resuscitation (CPR).
- Detailed discussions with patients or families around DNACPR or decisions to operate.
- Meticulous care in high-risk patients.

Recurrent themes raised during case review included:

- Lack of use of objective tools for risk stratification preoperatively.
- Excessive doses of anaesthetic drugs during both spinal and general anaesthesia.
- Lack of IABP monitoring.

Hip and other lower-limb fragility fractures

There were 33 cases of cardiac arrest involving hip (*n* = 27) or periprosthetic/revision hip surgery (*n* = 6) in the older-frailer cohort. This represents one in five cases of cardiac arrest in older-frailer patients. More than half (*n* = 22) were over 85 years and 30/33 had a CFS score over 5. There were two reports submitted of cardiac arrest following hip fracture outside the older-frailer cohort, but these are not considered here.

Objective risk assessment was documented in 8/33 cases (Nottingham Hip Fracture score in 5), qualitative risk assessment in 2 and was not carried out in 23 cases. General anaesthesia was used in 18/33 cases. For patients undergoing spinal anaesthesia with 0.5% bupivacaine the median volume was 2.2 ml (IQR 2–2.5 ml). Do not attempt CPR recommendations were documented in 20/33 cases.

The timing of cardiac arrest was around induction in five, during transfer/positioning in 2, intraoperatively in 23, in recovery in 2 and on the ward (within 24 hours) in 1.

There were 18 reports of BCIS. Of these, most were described as around or soon after the time of cementing, with one case more than five minutes after cementing. Death was reported in 20 of 33 cases overall and in 13 of 18 cases of BCIS.

The presenting signs were reported as bradycardia in 16 of 33, PEA in 11, asystole in 3, and atrial fibrillation and ventricular fibrillation in 1 apiece. Of note, bradycardia occurred as the initial sign in 11 of 18 cases of BCIS in the older-frailer cohort.

Discussion

We have identified older and frailer patients as a significant proportion of patients undergoing surgery in the UK. We estimate that almost 1 in 5 adult patients presenting for surgery are in the older and frailer cohort, of the order of at least 500,000 patients each year. These patients have more comorbidities than younger fitter patients, are more likely to be undergoing non-elective and more major surgery, and are more likely to experience complications. They are more likely to have a perioperative cardiac arrest and less likely to survive it if they do. Conversely, it is important to describe the absolute risks. Anaesthetists, surgeons and the wider perioperative team are providing care which means that the absolute risk of perioperative cardiac arrest is low. Even in this higher-risk cohort, the risk of perioperative cardiac arrest is around 1 in 1200 cases and of death about 1 in 2100.

Suboptimal decision making before, during and after surgery in frail and older patients is likely to have a more significant individual and collective impact than in younger fitter patients. There is evidence supporting early active management of older people undergoing surgery by specialist teams, but national data demonstrate variable reach of these services in elective (Joughin 2019) and emergency populations (NELA 2022) outside hip fracture care. It is beyond the scope of NAP7 to tell people exactly how to deliver safe anaesthesia in this cohort. However, we can exhort colleagues to ensure that they are providing care through all stages of the perioperative pathway that is cognisant of, and sympathetic to, the needs of the older-frailer patient. Of note, awareness of risks does not equate to avoidance of surgery. The panel was quite clear, and there were good examples of this, that surgery was appropriate, even though cardiac arrest occurred.

Risk assessment

The use of objective risk assessment tools was relatively low (30 of 156 cases, 19%), despite national recommendations for their use, and was a recurrent theme in review panel comments (lack of risk assessment highlighted in 18 of 156 cases, 12%). Risk assessment has many uses, including patient and family communication and planning the care pathway. It is discussed in detail in Chapter 19 Risk assessment, including with specific reference to the older-frailer patient. Of particular note, in the older-frailer patient, risk quantification, particularly hip fracture, may not always impact on the decision to proceed. The surgery offered is frequently palliative, and in that setting is aimed more at alleviating symptoms than prolonging life. Withholding surgery when this is the case is inhumane. However, even in this context, objective risk assessment may inform the process of perioperative care, aid discussions with patients and their family before surgery, and on occasion with the coroner or procurator fiscal in the event of death. The panel noted that in some cases the anaesthetists either had not appreciated the implications of frailty, or an inappropriate person (eg a relatively inexperienced anaesthetist in training) or technique were used despite a foreseeable high risk.

Do not attempt cardiopulmonary resuscitation recommendations and treatment escalation plans

Two issues pertain to DNACPR recommendations. First was the notable lack of any documented recommendation regarding CPR or treatment escalation in a significant proportion of the cases. This was despite combinations of advanced age, considerable frailty and type of surgery, which are predictably associated with a higher (although still low in absolute terms) risk of perioperative, and indeed later, postoperative cardiac arrest. In a few cases, reporters explicitly described conversations where discussion with patients and relatives had taken place and a choice to remain for CPR were made. However, it seems reasonable to assume that these were the minority. Second, the interpretation of national guidance (Griffiths 2015), particularly around the temporary suspension of DNACPR recommendations during surgery, may need to be nuanced. Treatment of drug-induced hypotension would seem part and parcel of minimal standards of good anaesthetic care. Chest compressions – even in the unconscious patient – are an invasive treatment, and the probability of survival, let alone good-quality survival, is low (although, of course, not zero). There are rightly divergent opinions on what is the right process for an individual, particularly those with advanced frailty, some may perceive death during anaesthesia a 'good' outcome, others may feel that dying with the family present is 'better'. But failure to consider and discuss this with patients and their families exposes patients to futile treatments. For some categories of patients, especially those recognised as very high risk, there may be benefit in proactive policies for management in case of perioperative deterioration. The topic of DNACPR recommendations, their suspension and this patient cohort is discussed further in Chapter 20 Decisions about CPR.

Drug dosing

NAP7 reports collected data on drug doses used for spinal anaesthesia but not for general anaesthesia. Concerns were raised in panel review over the doses of spinal anaesthesia used in frailer, older patients, particularly those with hip or periprosthetic fracture. The median dose of local anaesthetic used was at the higher end of recommended doses (Griffiths 2020). Although not necessarily a sole cause of cardiac arrest, the dose of intrathecal opioids was also questioned by the panel.

Reporters also identified relative drug overdose at the time of induction of anaesthesia as an issue in some reports and this was particularly associated with the use of total intravenous anaesthesia (TIVA). The panel had no opinion on the pros and cons of TIVA compared with volatile-based anaesthesia *per se* in this setting. The panel did note that the dose of propofol given at TIVA induction varies widely according to the pharmacokinetic

model selected but is available from the pumps before starting the infusion. This is discussed in detail in the Chapter 26 Drug choice and dosing.

Invasive arterial blood pressure monitoring

The panel discussed at length the (lack of) use of IABP monitoring in these patients, noting that this contrasts with its use in certain elective 'high-risk' settings. Higher-risk elective patients are objectively at a somewhat lower risk than the older-frailer patient undergoing urgent or emergency surgery. Notably, in the Activity Survey, the rates of IABP monitoring rose as CFS rose to 4 and then plateaued at CFS 5–6 before falling for patients of CFS 7–8. This means that, despite the fact that as frailty increases greater proportions of surgery are both non-elective and complex/major, frailer patients (CFS 5–8) receive either no more or less invasive arterial pressure monitoring. There is evidence that IABP monitoring leads to better control of blood pressure (Kouz 2022) and it is possible that its use would lead to earlier recognition of deterioration. However, evidence that it (or indeed almost any monitoring) alters outcomes *per se* is lacking. There was a consensus view that during induction of high-risk patients, high-frequency blood pressure monitoring (non-invasive or invasive) should be used. There was a majority view that increased adoption of IABP monitoring would probably have prevented some cardiac arrests, but there was no consensus. This is an area that merits further research.

Hypotension and cardiac arrest soon after induction

There were several cardiac arrests that occurred after induction and before or around the time of incision. In part, this is related to (exaggerated) responses to induction doses of drugs (spinal and general) and probably also due to the fact that the nadir of blood pressure will potentially coincide with periods of interruption of monitoring as a result of positioning, moving between anaesthetic room and operating room (where an anaesthetic room is used) and distraction by surgical or preparatory activity. These issues are discussed further in the Chapter 31 Monitoring and transfer and Chapter 32 Anaesthetic rooms but were evident in the older-frailer cohort of patients.

Bone cement implantation syndrome and hip fracture

The number of cases of BCIS was considerably lower than expected from previous case series, where the estimates of grade 3 BCIS (requiring resuscitation) are of the order of 1%. Given an estimated 30,000–35,000 hemiarthroplasties for hip fracture each year in the UK (National Hip Fracture Database 2022), a 1% rate would lead to around 300 cases per year, at least 10-fold greater than seen in NAP7. There are several non-exclusive possibilities for this discrepancy. It is likely that not every case will have been reported to NAP7. However, the overall perioperative cardiac arrest data are in line with previous estimates which argues against high levels of non-reporting. Some patients are likely to have had DNACPR recommendations in place and not suspended, so resuscitation was not started. Finally, the rate of BCIS may be significantly lower than previously reported. Of note, there was no mention in any of the reports of any aspects of the Association of Anaesthetist safety guideline on BCIS (Griffiths 2015), either positively or negatively. The data we have are unable to provide any evidence on the role of pressurisation of cement.

Mode of cardiac arrest

The mode of cardiac arrest was predominantly 'non-shockable' in line with other cases in NAP7. This to an extent makes recognition of cardiac arrest and distinction from 'ordinary dying' more difficult, compared with a dysrhythmic, sudden-onset event.

Cardiac ischaemia

Around one in seven of the cardiac arrest cases were attributed to cardiac ischaemia. This is perhaps unsurprising given the high rate of ischaemic heart disease in this population. However, it is likely, that in a proportion of these patients' preoperative (resuscitation, appropriate medical optimisation, drug management) and intraoperative (anaesthetic technique, blood management, monitoring) care may have modified this risk.

Other causes of death

Haemorrhage was recorded as a cause in 38 (24%) cardiac arrests in the older-frailer cohort, somewhat lower than the proportion of patients outside this cohort (30%). In most cases, haemorrhage related to vascular surgery. Haemorrhage is discussed further in Chapter 23 Major haemorrhage.

Septic shock was recorded as a cause in 16 (10%) cardiac arrests in the older-frailer cohort, slightly higher than in patients outside this group (8.4%).

Responses to and management of both hypovolaemic and septic shock will differ in the older-frailer patient from younger healthier counterparts and management of such acute cardiovascular deterioration should be within the skillset of all but the most junior anaesthetist.

Recommendations

National/institutional

- NAP7 supports the extant national recommendations that patients at risk of frailty (eg as a minimum all those over 65 years) should be screened for frailty early in their clinical pathway so accommodations can be made for optimal care (CPOC 2021a, 2021b).
- The Royal College of Anaesthetists' training and examinations syllabus should include consideration of appropriate anaesthetic techniques for older or frailer patients.

Institutional

- Where practical, treatment escalation plans, including but not limited to DNACPR recommendations, should be discussed and documented before arrival in the theatre complex in any patient having surgery with CFS score of 5 or above. Discussions should take place as early as possible preoperatively, with involvement of an anaesthetist, so that there is a shared understanding of what treatments might be desired and offered in the event of an emergency, including cardiac arrest.
- Departments should establish locally agreed guidelines on the indications for IABP monitoring in older and frail patients.
- Departments should ensure that decisions about offering anaesthesia and surgery to the older-frailer patient always incorporate information about the consequences, risks and probable outcomes of not operating as well as those of operating.

Individual

- There should be consideration of the choice, dose and speed of administration of induction drugs (whether given manually or by infusion) in older and frailer patients to avoid cardiovascular instability.
- In all high-risk patients, including the older-frailer patient, blood pressure should be monitored frequently at induction, whether invasively or non-invasively (eg every 30-60 seconds).
- Anaesthetists should use doses of intrathecal drugs that are appropriate to the age and frailty of the patient and the expected duration of surgery (Griffiths 2020).

Research

- Research should explore whether there is an impact on outcomes of IABP monitoring, particularly in older and frailer patients.
- Research should explore the current rates of BCIS, as they may somewhat lower than previously reported.
- Research should explore how and whether risk assessment changes patient, surgeon or anaesthetist behaviours and decision making.

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Appendix 28.1 Significantly older patients

The population of people in the UK over 85 years in 2020 was 1.7 million (2.5% of the population) but is projected to rise to 3.1 million (4.5% of population) by 2045 (ONS 2022).

In the NAP7 Activity Survey patients over 85 years:

- Accounted for 3.6% of all patients.
  - 44% more than the population proportion
  - A 29% increase from the 2.8% of surgical patients in 2013 (NAP5 survey).
- Were ASA 3 or above in 81% of cases.
- Had the highest proportion of BMI less than 18.5 kg m^{-2} in the survey (10% vs 2.2% for whole population) and the lowest proportions of overweight and obesity (15% vs 33%).
- Had a pre-existing DNACPR recommendation in 34%, with approximately 25% of these suspended for surgery.
- Experienced a complication during anaesthesia in 5.9%, which is no more than patients aged 36–85 years.
- Had a relatively higher risk of cardiovascular neurological and metabolic complications than younger patients.

In the patients over 85 years reported to NAP7:

- There were 63 cardiac arrests and 36 (57%) of these patients died.
- There were 7.2% of all cardiac arrests reported (63 of 881: a two-fold overrepresentation among cases).
- The incidence of cardiac arrest was 0.075% (1 in 1329, 7.5 per 10,000) and of death 0.043% (1 in 2326, 4.3 per 10,000). Both are similar to the incidence in patients designated older-frailer (over 65 years and graded CFS 5 of above).

Compared with patients in the Activity Survey who were over 85 (n = 757), patients over 85 years who had a cardiac arrest (n = 63) were more likely to be underweight (14% vs 9.6%), more likely to be ASA 4–5 (54% vs 21%), more likely to be frail (CFS ≥ 5, 75% vs 6%) but not notably more severely frail (CFS 7–8, 34% vs 28%). They were more frequently undergoing orthopaedic trauma surgery (65% vs 42%) or interventional cardiology (8.1% vs 0.8%), less likely to be having elective surgery (9.7% vs 45%) and more likely to be undergoing immediate or urgent surgery (60% vs 33%). They were more likely to be undergoing major surgery (69% vs 48%) rather than minor surgery (6.5% vs 21%) and perhaps more likely to be receiving combined general and regional anaesthesia than other anaesthetic types (29% vs 15%).

Compared with other patients who had a cardiac arrest (n = 757), those over 85 years were more often underweight (14% vs 1.3%) and less likely to be obese (11% vs 35%), of high ASA class (ASA ≥ 4–5 54% vs 35%), more likely to be white (94% vs 87%) rather than Black or Asian (5.3% vs 11.5%).

The majority of this group of patients (64%) were undergoing orthopaedic trauma surgery, mostly for fractured neck of femur. Cause of cardiac arrest was BCIS in 13 (16%) compared with 1.7% of all cases. Other prominent specialties were interventional cardiology and lower gastrointestinal surgery (both 8%).

The patient was judged a key cause of cardiac arrest in 61 (97%) of cases with anaesthesia and/or surgery also judged key factors in 38 (61%) cases. The patient was judged the sole key factor in 12 (19%) cases. In terms of contributory causes, the NAP7 panel judged that anaesthesia was a contributory more often than surgery.

Patients over 85 years who had a cardiac arrest were often frail (CFS ≥ 5, 74%, CFS 7–8, 34%), 41% had a DNACPR recommendation, of which half were suspended temporarily, 25% were active and status was unknown in 25%.

Time of day and phase of anaesthesia did not differ substantially from other cardiac arrests, although it was probably more common during regional anaesthesia (22% vs 6.5%). Location of cardiac arrest in those over 85 years was less often in remote locations or critical care than for younger patients.

Rhythm at cardiac arrest and management of cardiac arrest did not differ from younger patients, and cardiac arrest duration was not dramatically different, although shorter cardiac arrests were a little more common (< 10 minutes 79% vs 67%) and prolonged resuscitation was rarely undertaken (> 20 minutes 3.6% vs 11.4%).

The cardiac arrest was survived by 63% of patients (compared to 76% of those aged less than 85 years) but final outcomes were poor: death (73%) or severe harm (9.5%).

Care before cardiac arrest and overall was less commonly rated good in the over 85 years group than in other patients (23% and 26% vs 48% and 53%) and care before cardiac arrest in this group was more likely to be rated poor than in other patients (18% vs 11%), with other measures of care being broadly consistent with other groups.

In 29 cases where a judgement could be made, death was considered part of an inexorable process in 3 (15%), partially in 14 (48%) and not in 12 (41%).

Prominent themes discussed in case reviews were frailty, lack of a preoperative risk score, lack of invasive monitoring and high doses of drugs (both regional and general anaesthesia). A debrief was done or planned in 60% of cases where this was known, a similar proportion to all cases (61%).

Appendix 28.2 Significantly frailer patients

In the NAP7 Activity Survey, patients graded as CFS 7–8 :

- Accounted for 6.1% of all patients over 65 years.
- Underwent predominantly major surgery (49–56%).
- In CFS categories 7 and 8, 6.9% and 14.2% of patients, respectively, experienced complications compared with 5.5% in the whole population.

NAP7 reports in patients reported as CFS 7–8:

- Included 52 cardiac arrests and 31 (60%) of these patients died.
- Accounted for 5.9% of all cardiac arrests reported (52/881): which is in proportion to the surgical population.
- Indicate an incidence of perioperative cardiac arrest of 0.079% (1 in 1,272, 7.9 per 10,000) and of death 0.047% (1 in 2,143, 4.7 per 10,000). Both are similar to the incidence in patients designated older-frailer (over 65 years and scored CFS 5 of above).

There were no cases that were reported as CFS 9. The panel did take the view that a small number of patients were probably dying and surgery was ill judged. Conversely, in a small number of cases surgery was explicitly palliative and this was judged appropriate.

Compared with patients in the Activity Survey who were severely frail (n = 590), patients reported to NAP7 after cardiac arrest who were severely frail (n = 52) were more likely to be ASA 4 (62% vs 40%), more often Asian or black (7.7% vs 3.9%), less likely to be having elective surgery (9.6% vs 26%) and more likely to be undergoing immediate or urgent surgery (62% vs 47%), more likely to be undergoing major surgery (69% vs 48%) but did not differ particularly in age, weight categories, day, timing or extent of surgery or anaesthetic type.

Compared with other patients who had a cardiac arrest (n = 829) those with CFS 7–8 were more often female (54% vs 43%), older (40% > 85 years vs 5.1%), underweight (13% vs 1.6%), of high ASA class (ASA 4–5, 67% vs 35%), and somewhat more likely to be white (90% vs 82%).

Half (50%) of this group of patients were undergoing orthopaedic trauma surgery, mostly for hip fracture. Cause of cardiac arrest was bone cement implantation syndrome in 7 (10%) compared with 1.7% of all cases. A very wide range of causes of death were identified in this group including arrythmias (15%), emboli, metabolic issues, drug errors, omission of steroids and airway problems.

Of all patients of CFS 7–8, 19 (37%) had a DNACPR recommendation of which a little more than half were suspended temporarily.

The patient was judged a key cause of cardiac arrest in 47 (90%) of cases with anaesthesia and surgery judged key factors in 28 (54%) and 18 (35%) of cases, respectively. The patient was judged the sole key factor in 8 (15%) cases. Anaesthesia was judged a common contributory factor.

Time of day and phase of anaesthesia did not differ substantially from other cardiac arrests, although was likely more common during regional anaesthesia (15% vs 6.5%). Location of cardiac arrest in those with severe frailty was less often in remote locations or critical care than for non-severely frail patients.

Rhythm at cardiac arrest and management did not differ notably from non-severely frail patients, and cardiac arrest duration was not dramatically different though shorter cardiac arrest were a little more common (< 10 minutes, 77% vs 67%) and prolonged resuscitation was undertaken less often (> 20 minutes 9.6% vs 19%).

Early outcomes from cardiac arrest were not very different from other patients (67% survived vs 75%) but final outcomes were relatively poor: death (60%) or severe harm (4%).

Care before cardiac arrest and overall was somewhat less commonly rated good than in other patients (29% and 38% vs 8% and 53%) and care before cardiac arrest in this group was more likely to be rated poor than in others (17% vs 11%), with other measures of care being broadly consistent with other groups.

In 26 cases where a judgement could be made, death was considered part of an inexorable process in 3 (12%), partially in 12 (46%) and not in 11 (42%). In a small number of cases (< 5), resuscitation efforts were judged to have been inappropriately prolonged.

Prominent themes discussed in case reviews were lack of a preoperative risk score, lack of invasive monitoring and high doses of drugs (regional, general anaesthesia and sedation), although these themes were less prominent than in the group of patients over 85 years.

There were several cases with notably good care: attentive care of high-risk patients in whom cardiac arrest appeared unpredictable and unavoidable, several cases of avoidance of prolonged CPR in patients in whom a DNACPR recommendation was active, and good communication with families.

A debrief was done or planned in 61% of cases where this was known, the same as in all cases (61%).