Vascular surgery, ICU and HDU: a 14-year observational study

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ABSTRACT

INTRODUCTION Over the course of the past decade, numerous changes have occurred in the management of patients undergoing vascular surgical operations. The introduction of high dependency units (HDUs) has meant that many patients previously requiring observation in intensive care units (ICUs) are now managed in this new environment. In addition, many vascular patients may now be suitable for management on a vascular ward immediately following their surgery. This study reports the chronological changes in resource utilisation of patients undergoing major vascular surgery in a district general hospital over a 14-year period.

PATIENTS AND METHODS Details of all patients admitted to either the ICU or HDU under the care of a single vascular surgeon during the period 1991–2004 were extracted from a prospectively maintained anaesthetic department database. Details of the age and gender of the patients were obtained together with source of admission, place of discharge and need for re-admission. Operative details for each patient were extracted from a prospectively maintained vascular surgery database including type of procedure undertaken and degree of urgency.

RESULTS During the 14-year period under study, there was a dramatic decrease in the use of ICU facilities for the management of vascular patients from 100% in 1991 to 36% in 2004. There was a corresponding increase in the use of HDU for major vascular cases during the same period from 0% to 66%. However, despite a significant increase in the total number of major vascular operations performed, from 67 in 1991 to 185 in 2004 as a result of sub-specialisation, overall use of all high-care facilities fell as the number of patients returned directly to the vascular ward increased from 34% in 1991 to 64% in 2004. The efficacy of the choice of management venue was confirmed by the observation that only 7.7% of those managed on ICU had been initially managed at a lower level of care. In addition, only 1.8% of patients managed on HDU had been admitted after initially being managed on the vascular ward.

CONCLUSIONS Sub-specialisation over the past decade has meant a significantly increased major vascular work-load. Since the introduction of the HDU, there has been a significant fall in the use of ICU facilities for routine cases. These changes in resource utilisation have significant implications in terms of budget allocation. It would appear that finances, in relation to vascular surgery, should be concentrated on expanding HDU facilities and ensuring vascular surgery expertise amongst ward nursing staff.

KEYWORDS

High dependency unit – Intensive care unit – Vascular surgery

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The past two decades have witnessed a significant change in the management of patients undergoing major vascular procedures. The introduction of high dependency units (HDUs) has meant that many patients previously requiring monitoring on intensive therapy units (ICUs) are now managed in this new environment. These two facilities can clearly be identified in relation to their provision of organ support. An ICU provides an appropriate environment for management of Level 3 care, namely patients requiring

advanced respiratory support or moderate respiratory support and dysfunction of two or more other organ systems, whereas a HDU caters for patients requiring Level 2 care or support of a single failing organ or a patient in a postoperative state.¹

Furthermore, as a result of a number of changes in the management of a number of vascular pathologies over this period of time, such as the advent and popularisation of stenting, many patients who would have initially been nursed on a HDU may now be safely managed on the vas-

Table 1 Vascular surgical operations performed from 1991 to 2004

Operation	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CEA	0	2	5	12	13	27	36	24	33	43	37	41	44	38
AAA	26	39	38	28	29	37	34	39	55	40	40	35	45	54
AO	15	16	18	16	6	9	5	11	6	3	4	10	10	9
Fem-pop	7	9	13	13	13	9	17	18	24	27	15	28	38	40
Fem-fem	2	3	2	3	0	5	4	14	3	7	3	1	4	6
Ax-fem	4	7	6	5	11	5	4	3	4	7	4	0	0	1
Embolectomy	5	8	12	7	11	13	10	5	8	11	11	10	14	16
Endarterectomy	2	4	3	3	2	6	6	3	4	7	4	10	7	12
Aneurysms	5	2	0	4	5	5	12	4	3	7	2	3	6	5
Other	1	6	8	0	4	3	7	11	7	10	1	0	5	4
Total	67	96	105	93	94	119	135	132	145	162	124	138	173	185

cular ward. There is, however, little published data documenting clinical experience with these fundamental changes in management.

This study reports the chronological changes in resource utilisation of patients undergoing major vascular procedures in relation to relative use of ICU, HDU and the vascular ward for the management of patients following major vascular surgery.

Patients and Methods

The details of all patients admitted to ICU and HDU under the care of a single vascular surgeon during the period 1991–2004 were obtained from a prospectively maintained anaesthetic department database.

Demographic details of these patients including age, sex, source of admission and place of discharge were collected.

Table 2 Vascular and overall activity in ICU and HDU areas during the period 1991–2004

Year	ICU			HDU			Combined ICU+HDU		
	All cases	Vascular cases	Vascular as % of all ICU	All cases	Vascular cases	Vascular as % of all HDU	Total cases	% of vascular in HDU	% of vascular in ICU
1991	90	44	49	0	0	0	44	0	100
1992	108	51	47	65	27	42	78	35	65
1993	91	59	65	43	19	44	78	24	76
1994	70	32	46	65	31	48	63	49	51
1995	55	27	49	87	49	56	76	64	36
1996	85	52	61	43	32	74	84	38	62
1997	63	37	59	53	29	55	66	44	56
1998	70	45	64	45	41	91	86	48	52
1999	22	13	59	68	54	79	67	81	19
2000	32	12	38	85	63	74	75	84	16
2001*	19	16	84	26	24	92	40	60	40
2002*	22	19	86	56	44	79	63	70	30
2003	39	26	67	69	54	78	80	68	32
2004	26	24	92	52	43	83	67	64	36

*Consultant on sabbatical for a proportion of each year.

Table 3 Postoperative management of patients following major vascular surgery on ICU/HDU and wards in relation total major vascular workload

Year	Total major vascular cases	Major vascular managed on HDU+ICU	Major vascular managed on vascular ward	HDU/ICU (%)	Ward (%)
1991	67	44	23	66	34
1992	96	78	18	81	19
1993	105	78	27	74	26
1994	93	63	30	68	32
1995	94	76	18	81	19
1996	119	84	35	71	29
1997	135	66	69	49	51
1998	132	86	46	65	35
1999	145	67	78	46	54
2000	162	75	87	46	54
2001*	124	40	84	32	68
2002*	138	63	75	46	54
2003	173	80	93	46	54
2004	185	67	118	36	64

*Consultant on sabbatical for a proportion of each year.

Admission episodes to the ICU or HDU were regarded as primary if they occurred immediately from theatre whereas admissions following prior admission to a lower level of care (HDU or ward for ICU, and ward for HDU) were regarded as secondary admissions. Primary admissions were further divided into those following either an elective or emergency operation. Planned transfer from ICU to HDU as a result of an improvement in patient health was not regarded as an admission.

Details of the operative procedure and also the degree of urgency (emergency or elective) were obtained from a prospectively maintained vascular surgery database. The details of those patients who did not go to a critical care area were also obtained from this source and confirmed against ward log-books. Minor vascular operations such as amputations and varicose veins were not included in the data analysis.

Results

During the 14-year period covered by the study, 1549 patients underwent vascular surgical procedures and were admitted under the care of a single vascular surgery team to the combined facilities of ICU and HDU. The nature of the operations performed is summarised in Table 1. Of the total of 1549, 792 were admitted to ICU and 757 to HDU. Major vascular procedures represented 967 (62%) of the whole group; of these, 457 (47%) went to ICU and 510 (53%) went to HDU (Table 2).

In assessing the overall utilisation of critical care (ICU and HDU), vascular surgery patients made up half of the total number of admissions at the start of the study period, whereas, at the end of the study period, 92% of ICU admissions were vascular surgery patients and in the HDU patients treated for vascular disease represented 83% of admissions. In 1991, all patients went to ICU whereas, in 1992 the first year of operation of HDU, 35% of patients went to HDU; of this group, 42% had undergone vascular surgery. In 2004, 64% of patients admitted to a critical care bed having undergone surgery were admitted to HDU and only 36% went to ICU.

During the course of the study, as a result of sub-specialisation, the vascular workload increased 276% (Table 3). This may have been expected to have led to significant increases in the utilisation of critical care facilities; however, as a result of close multidisciplinary team-working and following internal audit, many of the patients traditionally admitted to critical care areas (such as those undergoing infra-inguinal bypass grafting or carotid endarterectomy) were managed primarily on the vascular surgery ward. As a result, the percentage of major vascular cases managed on the ward increased from 34% in 1991 to 64% in 2004.

There were no significant differences in gender or age between the groups throughout the duration of the study.

The vast majority of admissions to both the HDU and ICU units were primary transfers from theatre (Table 4) with elective cases dominating emergencies by 3.7:1 for ICU and

Table 4 Source of admissions to HDU and ICU units

Year	ICU			HDU		
	Routine	Emergency	Secondary	Routine	Emergency	Secondary
1991	37	5	2	NA	NA	NA
1992	42	9	0	26	1	0
1993	44	13	2	16	2	1
1994	23	7	2	16	2	1
1995	18	5	4	44	4	1
1996	47	3	2	30	1	1
1997	31	3	3	29	0	0
1998	30	13	2	39	1	1
1999	7	4	2	51	2	1
2000	8	1	3	62	1	0
2001*	6	6	4	21	2	1
2002*	11	5	3	36	7	1
2003	14	8	4	43	11	0
2004	15	7	2	37	5	1

NA, not applicable.

*Consultant on sabbatical for a proportion of each year.

'Part' years are shown as decimals and not months/weeks/days.

11.5:1 for HDU admissions. The number of emergency vascular admissions, which consisted mainly of ruptured aortic aneurysms, embolectomies and thrombolysis therapy, varied in number each year but never approached that of the elective admissions. The number of secondary admissions, namely from HDU to ICU or from ward to HDU/ICU, remained low throughout the duration of the study. The overall percentage of ICU admissions represented by secondary admissions was 7.7% most of which were patients undergoing emergency surgery or those developing complications on the HDU (23/45), whilst in the HDU this was even lower at 1.8%, these being exclusively complications.

Discussion

The primary finding of this study was that, during the 14-year period studied, there has been a move to sub-specialisation with a significant increase in the major vascular workload in excess of 270% compared with initial levels. This is a well-recognised phenomenon which was reported by our unit in 2000.² Interestingly, even in the past 6 years, the numbers have increased a further 50%.

During the period of the study, there was a re-distribution of services from ICU-only management at the beginning of the study to the current system in which twice as many patients are managed on HDU and ICU. Currently,

about half of all the vascular patients are managed on HDU, and a further third are transferred back to the ward, leaving a small group managed in the ICU environment. The success of the ward nursing of such patients is due to the development of a multidisciplinary approach and close co-operation between surgical and nursing staff as well as close interactions with the radiological department, a dedicated ward pharmacist and a readily available physiotherapist.

As well as a number of changes in the provision and pattern of critical care services, there have also been several changes in the pattern of vascular surgical practice offered to patients. In the early part of the study, HDU units were sparse in the UK and all vascular patients were managed in ICU facilities. Indeed, the first report of results from such a unit in the UK was by Coggins *et al.*³ in 1998 which described activity in their unit at the Countess of Chester NHS Trust between 1991 and 1996. The unit, which had opened in 1986, noted a significant growth in through-put, in particular vascular surgery, where patient numbers doubled. Surprisingly, the use of the ICU in Chester did not decrease during the duration of their study. Our HDU opened in 1991 as a result of pressures on the ICU, in particular those related to provision of vascular services, and since its opening has demonstrated an identical growth pattern. Despite the fact that HDUs are now present in almost all district general and teaching hospitals in the UK, there is

remarkably little published data confirming their value in the management of surgical patients.

The changes identified in vascular services in this study were in the main due to changes in the management of two vascular pathologies – aortic aneurysms and carotid artery stenosis. The development and popularisation of screening for abdominal aortic aneurysms (AAAs), and the recent publication of the results of MASS (Multicentre Aneurysm Screening Study), have indicated that this is a viable and effective treatment and reduces the numbers presenting with rupture.⁴ AAA screening has been performed in our region since 1991 and our findings have mirrored those of MASS.⁵ As a result of screening, more repairs will be performed on younger patients on an elective basis and, in many cases, a short HDU stay will suffice.

Many still advocate ICU management of all patients undergoing AAA repair,^{6,7} with figures of 59% (vascular) to 85% (non-vascular surgeons) reported in the UK and 77% amongst vascular surgeons in Canada. Since 1991, all patients undergoing AAA repair in our unit have been assessed by surgeon and anaesthetist pre-operatively and all are deemed suitable for HDU care unless a particular concern is identified' as a result, ICU beds are not reserved needlessly. All patients are always assessed again prior to being transferred from theatre but an escalation of care was very rarely required as indicated by the low transfer figures reported. Several papers have recently advocated HDU rather than ICU care for patients undergoing AAA repair.⁷⁻¹¹ A further consideration in respect to AAAs is the future role of endovascular stenting which, as a result of recent publications, is gaining in popularity.¹² Whilst none of the changes in this study were due to stenting of aneurysms, as the procedure is not performed at our unit, it is likely to be a factor in future assessments as AAAs will be managed back on the ward.

Following the publication of the European and American symptomatic carotid stenoses trials, there has been an upsurge in the performance of carotid endarterectomy.^{15,14} Several papers have evaluated the need for routine ICU care following endarterectomy and most have concluded that ICU care is only required for high-risk patients.¹⁵⁻¹⁷ More recently, there has been an increasing trend towards performing surgery under local anaesthetic and this is being investigated by the GALA (general anaesthetic versus local anaesthetic for carotid surgery) study.¹⁸ It is our policy that all patients undergoing endarterectomy, including both local and general anaesthetic, are managed on the vascular ward unless there is an abnormality identified on intra-operative monitoring.

It is difficult to provide confident data as to whether decisions to admit to ICU, HDU and ward care were correct as a proportion of patients will have developed complication no matter where they were managed and there is little

available data for comparison. Callaghan *et al.*,⁸ in a regional vascular unit setting, have recently reported on the use of overnight intensive recovery as an alternative to ICU in patients undergoing routine AAA repair and noted an ICU admission rate of 7% whereas our study was 7.7% for all vascular operations performed as elective and emergency cases. In relation to HDU re-admissions, there were only 9 cases in 14 years due to postoperative complications; thus, it can be concluded that the overwhelming number of management decisions were correct.

A further interesting observation was that there was no significant increase in the mean age of the populations being treated on either the HDU or ICU during the study. There was a slight increase in the age of the ICU cohort of 5 years from 66.6 years in 1991 to 71.5 years in 2004 but this was not a linear relationship. One reason for the lack of a significant increase in the mean age may be the fact that males over 60 years and women over 65 years in the region are screened for the presence of AAAs. As such, some of the potentially sickest patients (ruptured AAAs) are no longer presenting as emergencies but are presenting younger and in a fitter state and thus not requiring ICU stay. However, as the general population ages, they are presenting with other vascular pathologies; since many of this elderly cohort have significant co-morbidities, they often require ICU care thus keeping the mean age at just over 70 years.

One possible detrimental aspect of the use of HDU in preference to ICU, or ward in preference to HDU, is an increased morbidity and mortality. As a retrospective study, precise morbidity data are lacking for the cohort as a whole; however, in looking at the outcome data for three of the major vascular procedures (femoro-popliteal bypass, carotid endarterectomy and aortic aneurysm repair), a few observations are noteworthy. There has been no significant change in morbidity or mortality for lower-limb bypass surgery but results of endarterectomy and aneurysm surgery have improved, although this probably has little to do with the location of postoperative care. In relation to carotid surgery, the mortality rate is unchanged with no hospital mortality and only a single 30-day mortality, of an unrelated cause. The morbidity of local anaesthetic endarterectomy appears lower as neurological dysfunction is more easily identified allowing appropriate action to be undertaken. In relation to aneurysm surgery, there has been a reduction in both morbidity and mortality due, in the main, to the operation of an aneurysm screening programme in the region.

Conclusions

During the last 14 years, ICU use has fallen, HDU use has increased and the work-load has become more sub-specialised with vascular surgery patients forming a greater proportion of the critical care admissions, particularly to

HDU. The overall use of critical care services has remained stable as many vascular patients who previously were admitted to a critical care area are returning directly to the ward. These changes have certain implications on resource allocation in relation to vascular surgery which are starting to be explored.¹⁹ The decline in ICU use will lead to significant resource savings which may be directed elsewhere. Future investment should be directed at the expansion of HDU; as many more patients are cared for in a ward setting, spending should be directed to the provision of adequate numbers of nursing staff on the ward and to their education in the care of vascular surgical patients.

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