Concentration and choice in the provision of hospital services: summary report
NHS Centre for Reviews and Dissemination

Authors' objectives
To undertake systematic reviews of the literature on the relationship between the volume of hospital or consultant activity and clinical outcomes. The report also systematically reviews the relationship between the volume and scope of hospital activity and hospital costs and the relationship between concentration of hospital services, patient access and utilisation of services - these reviews will not be considered here. See Other Publications of Related Interest for details.

Searching
The following electronic databases were searched using both keywords and MeSH terms: MEDLINE (1980 to 1996), EMBASE (1974 to 1996), Health Planning and Administration (1975 to 1995), Dissertation Abstracts (1861 to 1996) and Entis. Search strategies are given in CRD Report 8 (I). In addition key relevant journals were handsearched, references of identified studies were checked and experts in the field and other Health Technology Assessment bodies were contacted to help identify published and unpublished studies.

Study selection
Study designs of evaluations included in the review
RCT, controlled trial, before/after, prospective cohort, retrospective cohort, case control, cross sectional.

Specific interventions included in the review
Studies where a comparison was made between the outcomes of patients treated in:

a. Hospitals/centres with different volume levels.

b. Actual death rates in units of high or low volume are compared with expected death rates.

c. Where outcomes are compared before and after concentration of services.

Participants included in the review
Patients receiving any of the following: cardio-vascular surgery (coronary artery bypass graft (CABG) surgery, other open heart, acute myocardial infarction and other heart problems, pacemaker implantation, cardiac catheterization/angiography, percutaneous transluminal coronary angioplasty (PTCA), carotid endarterectomy (CE), abdominal aortic aneurysms, vascular and cerebro-vascular surgery); respiratory medicine, abdominal procedures (gastric operations, cholecystectomy, appendicectomy, intestinal, hernia repair, gall bladder, ulcer); orthopaedic surgery (hip or knee arthroplasty, hip fracture); intensive care (neonatal/perinatal, paediatric, adult); urology/gynaecology (prostate, kidney/urinary tract infection and urology, hysterectomy, Caesarean section), trauma care; AIDS; cataract surgery; cancer and miscellaneous (for example patients with cirrhosis).

Outcomes assessed in the review
Mortality (in-hospital or other); morbidity (e.g. infection rates); psychosocial (e.g. satisfaction); quality of life. [A:No studies assessing psycho-social outcomes were identified]

How were decisions on the relevance of primary studies made?
The relevance of each individual study was assessed by one reviewer.

Assessment of study quality
Type of study design, process of patient identification, degree of adjustment for patient case-mix, avoidance of selection bias. The quality of each individual study was assessed by one reviewer. Patient case-mix adjustment scores were allocated by two reviewers.

Data extraction

Database of Abstracts of Reviews of Effects (DARE)
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Data were extracted in a systematic way by one reviewer. The data extraction sheet is presented in CRD Report 8 (1).

**Methods of synthesis**

How were the studies combined?
A qualitative overview is presented, taking into account the methodological rigour of each individual study. Where studies are similar enough (e.g. procedure, volume measure, patient type and outcomes measured) formal pooling of the data has been attempted. Studies are grouped according to the procedure or condition, and within this, studies have been ranked according to the extent of adjustment for patient case-mix.

How were differences between studies investigated?
Differences were discussed in the narrative.

**Results of the review**

Not all studies presented data on number of hospitals/doctors.

CABG surgery: 9 retrospective analyses (383,245 patients; 997 hospitals; 1,061 doctors).

Open heart: 4 retrospective analyses (39,320 patients, 830 hospitals).

Myocardial infarction/other heart: 1 prospective cohort (2,265 patients; 18 hospitals); 8 retrospective analyses (1,159,126 patients, 2,011 hospitals; 926 doctors).

Pacemaker implant: 2 retrospective analyses (201 patients; 1,752 hospitals).

Cardiac catheter/angiograph: 3 retrospective analyses (108,097 patients; 549 hospitals and 3,132 doctors); 1 survey (46,904 patients, 373 hospitals).

PTCA: 1 RCT (50 patients); 5 retrospective analyses (267,591 patients; 1,457 hospitals; 38 doctors).

CE: 1 pre-operation review (743 patients; 1 hospital; 24 doctors); 7 retrospective analyses (24,860 patients; 1,868 hospitals; 1,073 doctors).

Abdominal aortic aneurysm: 1 prospective multicentre cohort (444 patients, 26 hospitals); 9 retrospective analyses (39,825 patients; 2,305 hospitals; 874 doctors); 1 survey (294 patients, 17 hospitals).

Vascular/cerebrovascular surgery: 5 retrospective analyses (66,484 patients; 3,059 hospitals; 36 doctors).

Respiratory: 4 retrospective analyses (10,425 patients).

Gastric operation: 6 retrospective analyses (52,234 patients; 4,116 hospitals; 4,945 doctors).

Cholecystectomy: 10 retrospective analyses (459,703 patients; 7,617 hospitals; 9,384 doctors).

Appendicectomy: 4 retrospective analyses (132,122 patients; 1,676 hospitals; 6,434 doctors).

Intestinal: 9 retrospective analyses (142,673 patients; 3,307 hospitals; 7,433 doctors).

Hernia: 5 retrospective analyses (288,068 patients; 2,014 hospitals; 7,476 doctors).

Gall bladder: 1 retrospective analysis (88,839 patients; 1,210 hospitals).

Ulcer: 1 retrospective analysis (138,268 patients; 1,214 hospitals).

Hip/knee: 11 retrospective analyses (237,508 patients; 4,384 hospitals; 2,700 doctors).

Hip fracture: 5 retrospective analyses (146,233 patients; 4,534 hospitals).
Intensive care.

Neo/perinatal: 1 quasi experimental (matched control region) (7,394 patients); 1 before/after (87,213 patients); 2 prospective cohort (4,538 patients; 18 hospitals); 1 cohort (319 patients); 1 case control (1,179 patients; 39 hospitals); 1 case review (447 patients); 22 retrospective (6,038,834 patients; 2,219 hospitals; 715 doctors).

Paediatric: 2 prospective cohort (5,878 patients; 90 hospitals).

Adult: data from APACHE II study (11,612 patients; 26 hospitals).

Prostate: 7 retrospective analyses (253,861 patients; 2,604 hospitals; 2,892 doctors).

Kidney/urinary: 2 retrospective analyses (5,510 patients).

Hysterectomy: 4 retrospective studies (297,740 patients; 1,673 hospitals, 8,027 doctors).

Caesarean: 1 retrospective study (3,478 patients; 22 hospitals).

Trauma: 1 prospective comparative (2,646 patients); 1 cross- sectional comparison (182 patients; 40 hospitals); 7 before/after (73,569 patients; 68 hospitals); 1 case control (85 patients); 14 retrospective analyses (52,710 patients; 271 hospitals).

AIDS: 2 retrospective analyses (557 patients; 55 hospitals).

Cataract surgery: 1 stratified prospective cohort (772 patients; 75 doctors).

Cancer

Breast: 2 retrospective analyses (17,873 patients; 180 doctors).

Colorectal: 2 prospective cohort (1,239 patients; 7 hospitals; 56 doctors); 1 prospective audit (750 patients; 28 doctors); 3 retrospective analyses (23,781 patients; 1,156 hospitals; 434 doctors); 1 cohort (438 patients, 5 surgeons).

Pancreatic: 1 RCT (145 patients; 1 hospital; 5 doctors); 1 retrospective analysis (1,972 patients; 184 hospitals; 748 doctors).

Childhood: 2 retrospective analyses (4,438 patients).

Single retrospective analyses: teratoma (454 patients; 5 hospitals), oesophageal (1,143 patients), stomach (341 patients; 69 hospitals; 193 doctors), lung (12,439 patients; 389 hospitals), oncologic procedures (2,627 patients; 1 hospital).

Miscellaneous: 5 retrospective (31,883 patients; 938 hospitals); 1 analysis of routine (3,434 patients; 14 hospitals).

Results of studies with adequate adjustment for case mix (Grade III). Outcomes adjusted for case mix. OR=odds ratio of an adverse event in a higher vs. low volume unit. OR<1 less risk of a poor outcome in higher volume unit.

CABG surgery: reduced risk in-hospital mortality in hospitals >200 procedures/year (OR=0.90).

Paediatric heart surgery: reduced death rate in hospitals >300 case/year vs. hospitals <10 cases and <300 cases (OR=1/8 and 1/3).

Acute myocardial infarction: no significant difference in-hospital but higher 6 month mortality and lower rate of reinfarction in hospitals <300 beds (mortality 17% vs. 12%). Significant negative relationship for in-hospital mortality and physician (not hospital) volume.

Cardiac catheterization: no physician volume relationship. Mortality declines by 0.1% for a 100 increase in annual number of hospital procedures (average 400 treatments).
PTCA: No significant association for physician volume and angiographic or clinical success. Reduction in major complications when volume >400/year (OR =0.66). No physician volume relationship for mortality but more complications, emergency CABG and longer stay where physicians had <50 procedures/year. 20% mortality for physicians <4 and 15% for physicians >4 procedures/year.

Abdominal aortic aneurysms: SMR 30% higher in hospitals <14 patients/year. No surgeon relationship. 12% mortality for hospitals <6 procedures and 5% where >38/year. Double mortality in low volume surgeons (<6) vs. high volume surgeons (>26). Mortality declines by 1% for an increase of 4 operations/year/hospital (Average 23 treatments/year). No evidence of a surgeon volume effect. 2% increased odds of dying if in hospital <21 case vs. >21. Risk difference greater for ruptured aneurysms.

Amputation of lower limb (no trauma): SMR 16% higher in hospitals with below average annual volume (Average 10.5 treatments).

Gastric surgery: No significant difference for hospitals below and above average annual volume (average 24 treatments). Mortality declines by 1% for a 17 increase in annual number of hospital operations (average 38). No relationship for physician volume and mortality (average 8 treatments). Surgeons <2 procedures/year associated with higher mortality rate than those >1.

Cholecystectomy: SMR 26% higher in hospitals below average annual volume (Average 109 treatments). Hospitals <168 procedures a year had mortality rate of 1.52% vs. 1.21% in those with higher volume. No significant association with surgeon volume.

Intestinal operations (not cancer): hospital mortality higher (8.3%) when <40 operations/year vs. >40 operations (5.9%). Surgeons with annual volume >8 associated with lower mortality.

Gall bladder (non-surgical): SMR 14% lower in hospitals with below average annual volume (average 73 treatments).

Ulcer (non-surgical): No statistically significant effect of volume.

Knee replacement: Higher hospital volume associated with lower risk of complications (average 3.5 treatments).

Hip fracture: No significant effect of hospital volume on mortality (average 45 treatments).

Neonatal care: Infants <28 weeks gestation had better survival in intensive care units (>500 days ventilation/year) compared with special care units (<500 days of ventilation/year). No difference for more mature infants.

Paediatric intensive care: No statistically significant association for mortality and monthly volume.

Adult intensive care: No association for % dying and monthly unit volume.

Prostatectomy: No statistically significant differences.

Trauma care: No statistically significant association for mortality from major trauma and volume across A&E departments with volumes from <10/year to >90/year in 3 regions with/without an experimental trauma system. No major differences in mortality in a tertiary trauma unit for patients with mainly blunt injuries as it doubled in volume over 4 years.

Cataract surgery: surgeons >200 operations/year had a greater rate of adverse events (especially posterior capsular opacification OR 2.5)

AIDS: Risk of 30-day mortality 2.5 times higher when treated in low experience hospitals (<43 patients) than in a hospital >43 patients (30-day mortality RR 2.5).

Breast cancer: 15% reduction in mortality with surgeons >29 new cases/year. No advantage of >50 vs. >29.

Colorectal cancer: SMR 20% higher in hospitals with below average annual volume (average 50 treatments) or surgeon
volume (Average 8 treatments).

Laparotomy with colorectal resection: No statistically significant differences in mortality or morbidity for surgeons with 44-110 cases/year.

Stomach cancer: No statistically significant association for mortality and hospital or surgeon volume.

Malignant teratoma: 5 year mortality 60% lower in patients treated in a cancer unit that treated > 50% of patients with this cancer in the area.

Oesophageal cancer: 17% lower rate of operative mortality in surgeons <3 operations/year. 4% reduction in 5 year mortality for surgeons >5 new cases a year. Most explained by reduced operative deaths.

Pancreatic cancer: patients treated by surgeons with highest volume (76 cases in 20 months) had lowest risk of complications (fistula) vs. lower volume surgeons in same hospital.

Cost information
The review considers the relationship between volume and scope of activity and hospital costs. The authors conclude "On balance it is clear that there is little or no justification from the literature for greater concentration of services in the NHS on the basis of economies of scale arguments". [see Other Publications of Related Interest no.2]

Authors' conclusions
The literature on links between volume of activity and clinical outcomes suggests that for some procedures or specialties there may be some quality gains as hospital or clinician volume increases. In other areas the research suggests an absence of significant volume gains. Generalisation is clearly not possible on the basis of these results. Hence it would not be warranted to extrapolate the findings; whether positive or negative, outside the sample ranges or for the many procedures where the research evidence is too poor to suggest any conclusion. Where volume is associated with quality, the direction of causation is not established and there is no good evidence to indicate that increasing volume will actually result in improvements in health care outcomes

CRD commentary
This report was abstracted in conjunction with CRD Report 8 (1). This review was based on a clear research question. Thorough searches were carried out so it is unlikely that any relevant literature has been overlooked. Both the inclusion criteria and methodological quality assessment are clearly defined in the full Report (8 part 1). This report also contains the primary data, presented in tables containing the relevant dimensions of the included studies. The data were combined in an appropriate manner and ranked in accordance with their case mix-adjustment scores. However, although case-mix scores were allocated by two reviewers, relevance and quality assessment and data-extraction were undertaken by only one. Double-checking is desirable as it reduces bias and errors.

The authors' conclusions seem justified in terms of the results of the review and they warn against generalisation.

Implications of the review for practice and research
Practice: The authors state "In the few cases where volume quality links have been suggested by more reliable studies, these might well act as prompts for investigation by purchasers and/or clinicians. In some cases, the indicated thresholds are relatively low and could be reached through specialisation of tasks within a hospital rather than through an increase in the size of the provider". They also state that there is a need for a well-designed case-study analysis of the effects of trust or hospital mergers (which have already taken place) on costs and clinical outcomes.

Research: The authors state that there is a need for good-quality research to examine a broader range of indicators of outcome (such as quality of life or rates of re-admission or recurrence) and to establish the validity of the presumed benefits of sub-specialisation, multi-disciplinary working and inter-speciality links.

Bibliographic details
Other publications of related interest


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Subject indexing assigned by CRD

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.