

Effectiveness of interventions to reduce carbon-emissions within secondary healthcare: Systematic review and narrative synthesis

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Background

Whilst necessary for improving and maintaining human wellbeing, the environmental footprint of healthcare services contributes between 1% and 5% towards the total global environmental impacts.^{1, 2}

These environmental impacts, encompassing greenhouse gas emissions, reactive nitrogen in water, scarce water use, and nitrogen and/or sulphur dioxide emissions, adversely affect human health, through increasing disease and injury following climate related events, such as flooding and drought.^{1, 2}

In 2008, the Climate Change Act set national targets for the 100 percent reduction of carbon emissions in England of 1990 levels by 2050.³ The National Health Service (NHS) has an important role to help achieve these targets, as the organisation accounts for 4% of England's carbon-footprint.⁴ Sources of carbon emissions within the UK healthcare setting were calculated between 1990 to 2019; with the largest share of emissions being supply chains (62%), and other sources including delivery of care (24%), travel to and from NHS sites by staff, patients and visitors (10%) and private health and care services commissioned by the NHS (4%).² Figure 1 below provides a more detailed breakdown of sources of carbon emissions.⁴

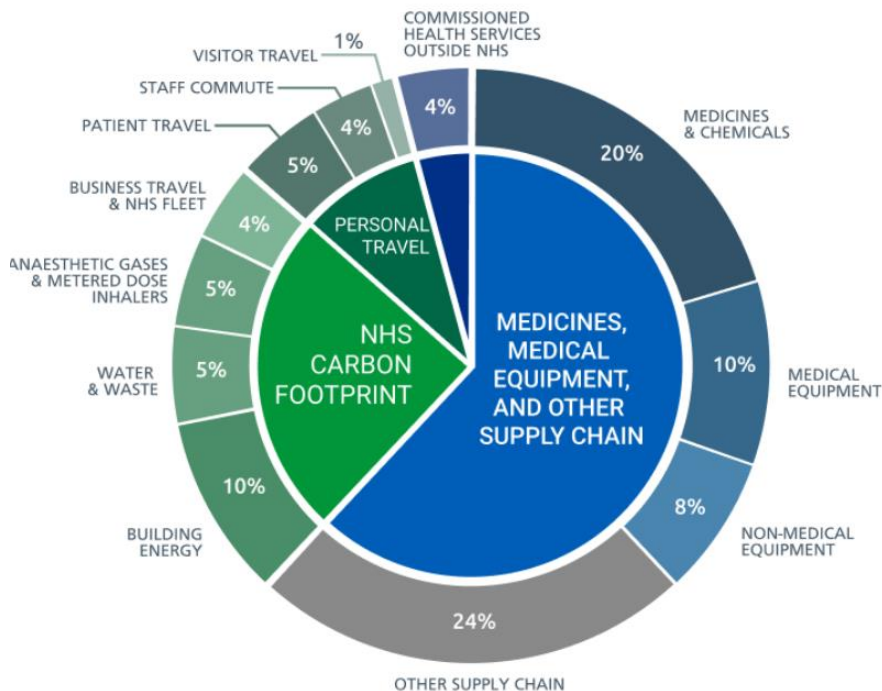


Figure 1: Sources of carbon emissions by proportion of NHS Carbon Footprint Plus

Policy context

Whilst the health and social care system in England achieved a reduction of 62% in carbon emissions between 1990 and 2020, NHS England have committed to achieve a reduction of 80% by 2028-2032 for emissions controllable by the NHS, creating a new national mandate for change.⁴

The Greener NHS, with the support of other NHS England policy teams, have been working closely with patients, clinicians, and industry to minimise emissions. Key areas of focus include emission reduction from medicines and anaesthetic gases, reducing waste, ensuring the right medicines are available to patients, and finding mechanisms to support shared, informed decision making.⁴

Work focusing on identifying and delivering interventions to reduce carbon emissions within the supply chain, feeding into clinical specialities is already underway, alongside examining the effectiveness of different models of care delivery across all specialities.^{4, 5}

Existing evidence-base

Scoping of the evidence base was carried out via MEDLINE, Science Citation Index, Google Scholar, and the HealthcareLCA database, the latter of which is a repository of life cycle assessment (LCA) studies which measure the environmental impacts of different aspects of healthcare. This indicates that there are some recent systematic reviews which examine different types of intervention to reduce carbon emissions. Four reviews focus on interventions to reduce carbon-emissions within operating theatres.⁶⁻⁹ Papadopoulou et al. (2022) examine the environmental sustainability of minimally invasive surgery techniques (including robotic and laparoscopic surgery) and include studies from a variety of different specialities which examine different interventions such as cost-awareness campaign on disposable use and reusable instruments or conduct a LCA for a particular surgical procedure.⁶ The number of studies evaluating/modelling the effect of an intervention in this review was limited (n=6), with hysterectomy/gynaecology and appendectomy being the main surgical specialties represented.⁶ In the review conducted by Perry et al (2022) studies evaluated interventions focusing on recycling and waste management, waste reduction, reuse, reprocessing/LCA, energy and resource reduction and anaesthetic gases.⁸ Searches were confined to the medical literature and carbon emission data was not routinely reported for all the included primary studies. Keil et al (2022) included LCA's which compared single-use and reusable healthcare products with similar functions.⁷ Interventions focused on non-invasive medical devices, inhalers, invasive medical devices (such as ureteroscopes, vaginal specula, laryngeal mask airways, central venous catheters, dental burs, scissors, anaesthetic equipment and instruments used in laparoscopic cholecystectomy) and protective equipment. The review synthesis predominantly focused on reporting of greenhouse gas emission data, without focusing explicitly on carbon-emissions, and without considering influence of

individual specialities.⁷ Finally, the review conducted by Siu et al (2016) compared the environmental impact of reusable vs disposable laparoscopic instruments.⁹ Searches for this review were limited to sources from the medical field and the review itself did not conduct quality appraisal for its included studies or report carbon-emission outcomes.

Two systematic reviews explored the environmental impact of telemedicine interventions in place of face-to-face patient care.^{10, 11} The review by Ravindrane and Patel (2022) encompassed renal medicine, head and neck cancer, vascular surgery and urology specialities.¹⁰ Whilst the review reports the impact of this type of intervention on carbon-emission, it does not calculate the use of telemedicine within different specialities.¹⁰ Lange et al (2022) apply a transparency checklist for carbon footprint calculations within a systematic review of virtual care interventions.¹¹ Overall, the review highlights a saving of 148kg carbon dioxide equivalents per patient, but does not calculate contributions of individual specialities/pathways and also highlights that evidence is weak and CF reports are highly heterogeneous.¹¹

To support the delivery of a Net Zero health service, further research is needed to identify and transform the most carbon intensive clinical pathways, while ensuring future models of care do not increase emissions.

Research aim

To carry out a systematic review which examines the effectiveness of interventions in reducing the carbon footprint for specific medical specialities within secondary care healthcare settings.

Research questions

What is the effectiveness of interventions for reducing the carbon footprint of medical interventions carried out in the following medical specialties within secondary healthcare:

- Cardiology
- Critical care
- Gastroenterology
- Oncology
- Ophthalmology
- Obstetrics
- Orthopaedics and trauma
- Radiology
- Renal
- Respiratory
- High volume low complexity surgery, including:
 - o Ear, nose and throat

- Gynaecology
- Urology

We have chosen to focus our research question on medical specialties with high levels of inpatient activity as these are likely to have the greatest impact on carbon emissions.

Identification of studies

The search strategy will be developed by an information specialist (SB) in consultation with the review team and stakeholders. Our overall approach will combine searches of bibliographic databases with backward and forward citation searches of studies which meet the inclusion criteria, web searches of topically relevant organisations, searches of Google Search, and checking the included studies of topically similar systematic reviews. In addition, we will inspect the Healthcare LCA database for relevant studies.

Our approach to searching bibliographic databases is informed by our scoping searches which revealed that potentially relevant studies for this review are sometimes published in environmental science journals which are not indexed in health care bibliographic databases. Thus, we will search a combination of bibliographic databases with coverage of both health care and environmental science journals, including the health care databases MEDLINE and Embase (both via Ovid), the environmental science database Environment Complete (via EBSCO) and the multidisciplinary Science Citation Index database (via Web of Science, Clarivate Analytics). Searches of MEDLINE and Embase will combine search terms for carbon emissions with search terms for relevant specialties (see draft MEDLINE search in Appendix 1). Medical specialty terms will include generic terms for each specialty (e.g. gastroenterology, cardiology, etc.), diseases within each specialty which are treated in secondary care settings, and procedures within each specialty which are carried out in secondary care settings. A different approach will be used to search Environment Complete and the Science Citation Index which combines search terms for carbon emissions with generic terminology for hospital settings and secondary care. This approach is informed by our scoping searches which suggest that potentially relevant studies published in environmental science journals typically use more generic terminology to describe medical settings than studies in medical and health care journals. A date limit of 2008 will be applied across all databases (see Inclusion Criteria, below) and English language limits will be applied where available. The results of the bibliographic database searches will be exported to Endnote 20 (Clarivate Analytics, Philadelphia, PA, USA) and de-duplicated using the automated de-duplication feature and manual checking.

We will supplement our bibliographic database searches by inspecting the HealthcareLCA database (<https://healthcarelca.com/>). This regularly updated resource indexes studies of life cycle assessments

of medical technologies and procedures, including carbon emissions, and can be filtered to identify studies relevant to specific medical specialties, including several specialties which are included in this review. We have inspected the search strategies which were developed to populate this database (received via email correspondence with the database developers), and have ascertained that they are based on a prior systematic review on lifecycle assessments of surgical procedures.¹² Having assessed both sets of searches we are confident that we can rely on the HealthcareLCA database for studies in which surgery is generically described (e.g. 'surgery', 'surgical'), and can potentially retrieve additional studies via our bibliographic database searches by searching for specific surgical procedures for each of our included medical specialties. (The HealthcareLCA database also indexes studies not related to surgery, and we may also identify further such studies through inspection of the included studies; however, owing to the database's inception as based on a systematic review of surgical procedures we are mainly confident of retrieving studies related to surgery from this source).

Forward and backward citation searches will be conducted on all studies that meet our inclusion criteria. Forward citation searching will be carried out via the Science Citation Index (Web of Science, Clarivate Analytics) and Google Scholar (<https://scholar.google.co.uk/>), depending on which citation index indexes the relevant studies which we identify. We will also check the included studies of any topically relevant systematic reviews that we identify during the screening process.

Google Search will be searched to identify studies not indexed in bibliographic databases or citation indexes, such as hospital-led evaluations published in grey literature format. Finally we will search a selection of websites for relevant studies, including:

- Centre for Sustainable Healthcare <https://sustainablehealthcare.org.uk/>
- Current Awareness Service for Health <https://cash.libraryservices.nhs.uk/>
- European Centre for Environmental and Human Health <https://www.ecehh.org/>
- Health Care Without Harm <https://noharm-europe.org/>
- IHSCM – Greener care special interest group <https://ihm.org.uk/special-interest-groups/greener-care/>
- Green Health Wales <https://greenhealthwales.co.uk/>
- Greener NHS <https://www.england.nhs.uk/greenernhs/>
- Sustainable Healthcare Networks Hub <https://networks.sustainablehealthcare.org.uk/>

Inclusion Criteria

The inclusion criteria and exclusion criteria to be applied to the studies identified through the search strategy are detailed below.

Population

Include:

Procedures, processes or pathways within the following specialties:

- Cardiology
- Gastroenterology
- Obstetrics
- Oncology
- Ophthalmology
- Orthopaedics and trauma
- Radiology
- Renal
- Respiratory
- High volume low complexity surgery, including:
 - o Ear, nose and throat
 - o Gynaecology
 - o Urology

The final list of specialities was agreed in consultation with the Greener NHS team at NHS England. The list is based on inpatient hospital data showing high volumes of activity with subsequent implications for carbon footprints.

Exclude:

Any procedures, processes or pathways within specialities not listed above.

Intervention

Include:

Any intervention intended to reduce the environmental impact of a process, treatment or pathway. Examples of eligible interventions include (but are not limited to): waste reduction, remote clinics, surgical techniques, technology/instruments, treatment pathways, manufacturing, imaging, tests, and medication.

Exclude:

Any intervention associated with a speciality not listed above;

Comparator

Any comparator

Outcome

Include:

Carbon-emission data must be included;

Estimated carbon-emissions based upon LCA also eligible.

Exclude:

Studies only reporting only outcomes related to patient clinical, safety and/or satisfaction.

Setting

Include:

Healthcare delivered within secondary care, including: travel to/from/between secondary sites and remote delivery of care.

Exclude:

Any treatment, pathway or process associated with the above listed specialties in primary or community healthcare settings e.g., General practice

Community nursing care

Additional inclusion/exclusion categories (study design, date limit, geographical location)

Study design:

Include:

Any comparative study design, including (but not limited to):

- Randomized controlled trials;
- Controlled trials;
- Prospective and retrospective cohort studies
- Before and after studies
- Interrupted time series
- Modelling studies;
- Life Cycle Assessments which compare different treatment/processes.

Exclude:

- Life Cycle Assessments which provide only an estimate of carbon-emissions associated with a particular treatment/process but present no comparison between different treatment/process options;
- Case studies;
- Systematic, scoping or narrative reviews;

- Qualitative studies.
- Conference abstracts

If necessary, we will further limit study design eligibility in order to include the most relevant and robust evidence within the review.

Date limit:

Studies published since 2008, which is the year of the UK Climate Change Act.³ The HealthcareLCA database published a graph which indicates that few LCA studies have been published before this date.¹³

Geographical limit:

None. Language restriction:

Studies published in English only.

Process of applying inclusion criteria

As an initial calibration exercise of inclusion judgments and the clarity of our inclusion criteria, all reviewers will apply inclusion and exclusion criteria to the same sample (n=100) of search results. Decisions will be discussed in a group meeting to ensure consistent application of criteria. Where necessary, inclusion and exclusion criteria will be revised to enable more consistent reviewer interpretation and judgement. The revised inclusion and exclusion criteria will then be applied to the title and abstract of each identified citation independently by two reviewers, with disagreements resolved through discussion or referral to a third reviewer as required. The full text of each record will be assessed for inclusion in the same way.

Endnote 20 software will be used to support study selection. A PRISMA-style flowchart will be produced to detail the study selection process and reason for exclusion of each record retrieved at full text will be reported.

Data extraction

A standardised data extraction coding set will be developed and piloted by the review team on a selection of included studies. It will be used to collect the following information from each included full text:

- First author
- Date of publication
- Title of publication
- Study aims and objectives

- Data collected
- Data collection method
- Data analysis performed
- Healthcare specialty
- Study setting
- Inclusion criteria
- Participant characteristics (age, job role, health condition)
- Details of treatment/pathway
- Intervention aims
- Intervention and comparator characteristics (based on TIDieR checklist)
- Comparator used for carbon-emission comparison/calculation
- Comparator characteristics
- All outcomes assessed in study
- Summary of patient outcome data where reported, including clinical effectiveness and patient safety and satisfaction
- Carbon-emission data
- Summary of key findings (based on paper abstract)

If we have sufficient time we will also extract data related to health equity where this is reported using relevant items in the PROGRESS-Plus framework.¹⁴ Data extraction will be performed by one reviewer and checked by a second, with disagreements being settled through discussion, recruiting a third person as arbiter, if required.

Study quality assessment strategy

The quality of all studies selected for inclusion following purposive sampling will be appraised using a suitable appraisal tool. All assessments will be performed by one reviewer and checked by a second, with disagreements settled by a third reviewer if necessary.

Data analysis and presentation

Data from the included studies will initially be tabulated and summarised narratively. Given the expected heterogeneity in study designs, population and intervention characteristics, we do not anticipate being able to conduct a meta-analysis. Instead, we will group studies with similar intervention and population characteristics with a view to conducting a narrative synthesis. Where possible, this will enable us to identify key features of successful interventions and identify gaps in the evidence base where further research is required.

Policy Relevance

This review was requested by stakeholders from Greener NHS England team.

Stakeholder involvement

Our government stakeholders have been instrumental in determining the aims and scope of the review. Thus far, they have been involved with the identification of the review's research question and development of the review protocol. This involvement will continue throughout the review and involve:

- Commenting on search strategy
- Commenting on relevance of included studies;
- Commenting on final data extraction form;
- Providing feedback on preliminary results;
- Commenting on draft report;
- Supporting dissemination of findings.

Hospital based clinicians will also be asked to contribute towards the stages of the review listed above.

Patient and public involvement

We will seek to involve patients and members of the public in the conduct of this review by drawing upon the experience of our patient and public involvement group. Key areas for integrating their feedback during the review process include:

- Defining our research question;

- Developing the project protocol;
- Checking what level of information will be useful to the intended users of our review;
- Ensuring our review of available evidence is accessible to our intended audience;
- Providing feedback on preliminary findings and draft reports;
- Identifying opportunities for dissemination of findings.

Dissemination plans

We will produce a final project report which will be sent to our key stakeholders. The results from this review will be published within relevant academic journals. We will also produce plain language summaries with our PPI group, which can then be used as a basis for other dissemination materials the research and stakeholder team feel are appropriate. These dissemination materials may include a Briefing paper, podcast and blog post. Key outputs will be shared via the Exeter PRP ERF webpage, blog and Twitter feed.

The dissemination plan will be developed further as the findings of the review emerge to allow for the key messages and delivery mechanisms for each audience to be identified.

Resources

The estimated timeline is a minimum of 7.5 months, based on the whole team working full time on this review. This timeframe may be influenced by the other requests for work by the Exeter PRP Evidence Review Facility. In such circumstances, the timeline will be renegotiated through discussion between Exeter PRP Evidence Review Facility, our commissioners and stakeholders from NHS England (Greener NHS).

This review will include input from all members of the Exeter Policy Research Programme Evidence Review Facility. We will also seek to consult with review stakeholders, patients and members of the public at key stages throughout the review process, as detailed in the 'Stakeholder involvement' section above.

References

1. Lenzen M, Malik A, Li M, Fry J, Weisz H, Pichler PP, et al. The environmental footprint of health care: a global assessment. *Lancet Planet Health*. 2020;4(7):e271-e9.
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3. Climate Change Act, c. 27 (2008) Available from: <https://www.legislation.gov.uk/ukpga/2008/27/contents>.
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7. Keil M, Viere T, Helms K, Rogowski W. The impact of switching from single-use to reusable healthcare products: a transparency checklist and systematic review of life-cycle assessments. *European Journal of Public Health*.
8. Perry H, Reeves N, Ansell J, Cornish J, Torkington J, Morris DS, et al. Innovations towards achieving environmentally sustainable operating theatres: A systematic review. *Surgeon*. 2023;21(3):141-51.
9. Siu J, Hill AG, MacCormick AD. Systematic review of reusable versus disposable laparoscopic instruments: costs and safety. *ANZ J Surg*. 2017;87(1-2):28-33.
10. Ravindrane R, Patel J. The environmental impacts of telemedicine in place of face-to-face patient care: a systematic review. *Future Healthc J*. 2022;9(1):28-33.
11. Lange O, Plath J, Dziggel TF, Karpa DF, Keil M, Becker T, et al. A Transparency Checklist for Carbon Footprint Calculations Applied within a Systematic Review of Virtual Care Interventions. *Int J Environ Res Public Health*. 2022;19(12).
12. Drew J, Christie SD, Tyedmers P, Smith-Forrester J, Rainham D. Operating in a Climate Crisis: A State-of-the-Science Review of Life Cycle Assessment within Surgical and Anesthetic Care. *Environ Health Perspect*. 2021;129(7):76001.
13. HealthcareLCA. Cumulative data sources within the HealthcareLCA database disaggregated by healthcare field assessed [Figure]. 2021 [Available from: <https://healthcarelca.com/cumulative-data-sources-within-the-healthcarelca-database-disaggregated-by-healthcare-field-assessed>].
14. Cochrane Methods. PROGRESS-Plus 2023 [Available from: <https://methods.cochrane.org/equity/projects/evidence-equity/progress-plus>].

Appendix 1. Ovid MEDLINE draft search strategy

1. ((carbon or CO2 or CO2e) adj3 (emission* or footprint or impact* or output or green* or sustainab*)).tw.
2. (greenhouse adj1 (effect or gas*)).tw.
3. (("life cycle" or lifecycle) adj1 (analys?s or assessment*)).tw.
4. ((climate or environment*) adj1 (footprint or impact* or sustainab*)).tw.
5. Carbon Footprint/
6. Greenhouse Gases/
7. Air Pollutants, Occupational/
8. Global Warming/
9. environmental indicators/
10. or/1-9
11. (gastro* or gastric*).tw.
12. (gi adj1 (disease* or disorder*)).tw.
13. ((bowel or gi or intesti* or liver or stomach) adj1 (assessment* or biops* or bleeding or cirrhosis or disease* or disorder* or failure or illness* or cancer* or carcinoma* or tumour* or tumor* or neoplasm*)).tw.
14. ("abdominal adhesion*" or appendicitis or "barrett's esophagus" or "celiac disease" or "colon polyps" or "crohn's disease" or "esophageal varices" or "pancreatic insufficiency" or gallstones or gastritis or h?emorrhoid* or hernia* or colitis or pancreatitis or "peptic ulcer*" or "stomach ulcer*" or proctitis or pylori).tw.
15. Gastroenterology/
16. exp Gastrointestinal Diseases/
17. (appendectomy or colonoscop* or duodenoscop* or endoscop* or gastroscop* or colectomy).tw.
18. exp Endoscopy, Gastrointestinal/
19. manometry.tw.
20. exp Manometry/
21. (barium adj1 (enema or swallow)).tw.
22. (cholangiography or cholangiopancreatography).tw.
23. exp Cholangiography/
24. (esophagogram or electrogastrogram).tw.
25. exp Digestive System Surgical Procedures/
26. exp digestive system neoplasms/

27. or/11-26
28. 10 and 27
29. (orthopedic* or orthopaedic* or musculoskeletal).tw.
30. Orthopedics/
31. exp Musculoskeletal System/
32. ((ankle or bone or cervical or elbow or femoral or finger or hand or hip or joint or knee or neck or shoulder or spine) adj2 (break or broken or fracture*)).tw.
33. (bone adj1 (cancer* or carcinoma* or tumour* or tumor* or neoplasm*)).tw.
34. exp Fractures, Bone/
35. ("carpal tunnel" adj2 (syndrome or release)).tw.
36. Carpal Tunnel Syndrome/
37. osteoporosis.tw.
38. exp osteoporosis/
39. ((ankle or bone or cervical or elbow or femoral or finger or hand or hip or joint or knee or neck or shoulder or spine) adj2 (arthroplast* or arthroscop* or implant* or reconstruction or repair or replacement)).tw.
40. (cementoplasty or diskectomy or "fracture fixation" or "intervertebral disc chemolysis" or laminectomy or laminoplasty or "orthopedic manipulation posterior cruciate ligament reconstruction" or "ulnar collateral ligament reconstruction" or viscosupplementation).tw.
41. exp Orthopedic Procedures/
42. (trauma adj1 (care or "life support" or medic*)).tw.
43. Trauma Centers/
44. exp bone neoplasms/
45. or/29-44
46. 10 and 45
47. (cardiolog* or cardiovascular).tw.
48. exp Cardiology/
49. Cardiology Service, Hospital/
50. ((cardiac or heart) adj3 (arrest or attack* or disease* or disorder* or defect* or dysfunction or failure or sarcoma or transplant*)).tw.
51. "myocardial infarction".tw.
52. ((aortic or artery or arterial) adj1 disease).tw.
53. "intermittent claudication".tw.
54. aneurysm.tw.

55. hypertension.tw.
56. exp Hypertension/
57. exp Heart Diseases/
58. (angioplasty or "arterial switch operation" or "artificial heart valve" or "heart valve replacement" or atherectomy or "cardiac valve annuloplasty" or cardiomyoplasty or "heart bypass" or "heart massage" or "heart valve prosthesis implant*" or "maze procedure" or revascularization or vascularization or "norwood procedures" or "pericardial window techniques" or pericardiectomy or pericardiocentesis).tw.
59. exp Cardiac Surgical Procedures/
60. exp Angioplasty/
61. stent*.tw.
62. exp Stents/
63. exp cardiac imaging techniques/
64. exp heart neoplasms/
65. or/47-64
66. 10 and 65
67. ophthalm*.tw.
68. Ophthalmology/
69. (cataract* or glaucoma).tw.
70. "macular degeneration".tw.
71. "diabetic retinopathy".tw.
72. exp Eye Diseases/
73. ((eye* or retina*) adj3 (care or detachment or disease or disorder* or cancer* or carcinoma* or tumour* or tumor* or neoplasm*)).tw.
74. "intravitreal injection*".tw.
75. Intravitreal Injections/
76. (blepharoplasty or dacryocystorhinostomy or "eye enucleation" or "eye evisceration" or "filtering surgery" or sclerostomy or trabeculectomy or iridectomy or "light coagulation" or "laser coagulation" or "orbit evisceration" or "corneal transplant*" or "radial keratotomy" or "lens implant*" or "posterior capsulotomy" or scleroplasty or "scleral buckling" or vitrectomy).tw.
77. exp Ophthalmologic Surgical Procedures/
78. exp eye neoplasms/
79. or/67-78

80. 10 and 79
81. ((lung or pulmonary or respiratory) adj3 (care or disease* or disorder* or cancer* or carcinoma* or tumour* or tumor* or neoplasm*)).tw.
82. Pulmonary Medicine/
83. ("chronic obstructive pulmonary disease" or COPD).tw.
84. lung diseases, obstructive/
85. exp pulmonary disease, chronic obstructive/
86. ((emergency or hospital or medical or therap*) adj3 oxygen).tw.
87. (bronchoscop* or "endobronchial ultrasound" or bullectomy or "chest drain" or "lung transplant*").tw.
88. exp Respiratory Therapy/
89. bronchoscopy/
90. exp Diagnostic Techniques, Respiratory System/
91. asthma.mp. or inhaler*.tw. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word]
92. Asthma/
93. respiratory tract neoplasms/
94. or/81-93
95. 10 and 94
96. nephrolog*.jn,tw.
97. Nephrology/
98. (renal or kidney*).jn,tw.
99. ((renal or kidney) adj3 (acute or chronic or disease* or "end stage" or failure or injury or injuries or transplant* or cancer* or carcinoma* or tumour* or tumor* or neoplasm*)).tw.
100. nephropathy.tw.
101. exp Kidney Failure, Chronic/
102. exp Kidney Diseases/
103. exp Renal Replacement Therapy/
104. ((kidney or renal) adj3 (therap* or replacement or transplant*)).tw.
105. (dialysis or h?emodialysis or h?emofiltration or h?emoperfusion or lithotripsy).tw.
106. exp Carcinoma, Renal Cell/

107. or/96-106
108. 10 and 107
109. ("critical care" or "intensive care" or intensivist* or icu).jn,tw.
110. (serious adj1 (accident* or injur* or infect*)).tw.
111. exp Critical Care/
112. or/109-111
113. 10 and 112
114. exp Gynecologic Surgical Procedures/
115. (colposcopy or colpotomy or "culdoscopy dilatation and curettage" or "endometrial ablation" or hysterectomy or hysteroscopy or ovariectomy or salpingectomy or salpingostomy or "tubal sterilization" or "uterine artery embolization" or "uterine myomectomy" or vulvectomy).tw.
116. 114 or 115
117. 10 and 116
118. exp Urologic Surgical Procedures/
119. (cystectomy or cystoscopy or cystotomy or "kidney Transplant*" or nephrectomy or nephroureterectomy or nephrolithotomy or nephrotomy or nephrostomy or "transurethral resection" or ureteroscopy or "urinary diversion" or ureterostomy or "male circumcision" or orchiectomy or orchiopexy or "penile Implantation" or prostatectomy or vasectomy or vasovasostomy).tw.
120. 118 or 119
121. 10 and 120
122. exp Otorhinolaryngologic Surgical Procedures/
123. (adenoidectomy or laryngectomy or laryngoplasty or laryngoscopy or rhinoplasty or "neck dissection" or "auditory brain stem implant*" or "cochlear implant*" or "endolymphatic shunt" or "labyrinth fenestration" or mastoidectomy or "middle ear ventilation" or myringoplasty or "ossicular replacement" or "transtympanic micropressure treatment" or tympanoplasty or pharyngectomy or pharyngostomy or tonsillectomy or tracheostomy or tracheotomy).tw.
124. 122 or 123
125. 10 and 124
126. exp chemoprevention/
127. exp chemoradiotherapy/
128. exp chemotherapy, adjuvant/

129. exp consolidation chemotherapy/
 130. (chemotherapy or chemoprevention or chemoradiotherapy or radiotherapy).tw.
 131. oncolog*.tw.
 132. exp Medical Oncology/
 133. antineoplastic*.tw.
 134. exp Antineoplastic Agents/
 135. or/126-134
 136. 10 and 135
 137. obstetric*.tw.
 138. exp obstetrics/
 139. ((oxytocin or labo?r) adj3 induc*).tw.
 140. ("electro f?etal monitoring" or "continuous EFM").tw.
 141. (amniotomy or enema or epidural or episiotomy).tw.
 142. ("artificial rupture" adj2 membranes).tw.
 143. ("cervical cerclage" or colposcop* or colpotomy or culdoscop* or fetoscop* or hysteroscop* or hysterotomy or "umbilical cord clamp*").tw.
 144. abortion*.tw.
 145. (terminat* adj2 pregnancy).tw.
 146. exp Pregnancy Complications/
 147. exp Obstetric Surgical Procedures/
 148. or/137-147
 149. 10 and 148
 150. (radiolog* or radiotherap*).tw.
 151. exp Radiology/
 152. (angiography or "CT scan" or echocardiogram or "electrocardiogram" or "magnetic resonance imag* MRI" or "PET scan" or tomography or ultrasound or "x ray").tw.
 153. (CT adj2 (micro or "high resolution" or "volumetric quantitative")).tw.
 154. ((medical or fluoroscopic*) adj2 imag*).tw.
 155. exp Diagnostic Imaging/
 156. or/150-155
 157. (health or hospital* or medical or medicine or pharmaceutical).tw.
 158. exp Hospitals/
 159. Hospital Medicine/
 160. or/157-159

- 161. 10 and 156 and 160
- 162. 28 or 46 or 66 or 80 or 95 or 108 or 113 or 117 or 121 or 125 or 136 or 149 or 161
- 163. limit 162 to (english language and yr="2008 -Current")