Introduction

Ireland's most recent National Health Strategy - "Quality & Fairness – A Health System for You" included a commitment by the Department of Health and Children to undertake a review of paediatric services. In line with that commitment and following a procurement process, the HSE commissioned McKinsey & Company to prepare a report advising on the 'strategic organisation of tertiary paediatric services for Ireland' that would be 'in the best interests of children'. The terms of reference specified:

"The report and its recommendations should be informed by:

1. International best practice
2. Working models in the delivery of paediatric care
3. Current and projected demographics in Ireland
4. The inter-relationship between secondary and tertiary care provision for children
5. The requirement to provide paediatric secondary care and A&E services for children in the greater Dublin catchment area
6. Emerging clinical trends
7. Technological developments

Specifically the report must identify:

- Whether tertiary paediatric services should in future be provided at one or more locations
- Facilities required to meet tertiary paediatric needs e.g. Beds - inpatient, day, icu; theatres; diagnostic facilities – radiology, pathology; outpatient facilities
- Appropriate facilities (beds etc.) required to meet secondary paediatric service needs in Dublin"

The report and its recommendations must be:

1. Evidentially based
2. Fully documented

This report and its recommendations will be used to inform HSE future decisions on paediatric care

In accordance with the terms of reference this effort was focused on identifying emerging international best practices and their implications for Ireland. In this context, we were not briefed to consult with experts and practitioners in Ireland and did not have access to detailed hospital specific data on the nature and quality of care.

Our appointment was confirmed on December 22nd and the work was completed on February 1st 2006. This report presents our findings and recommendations.

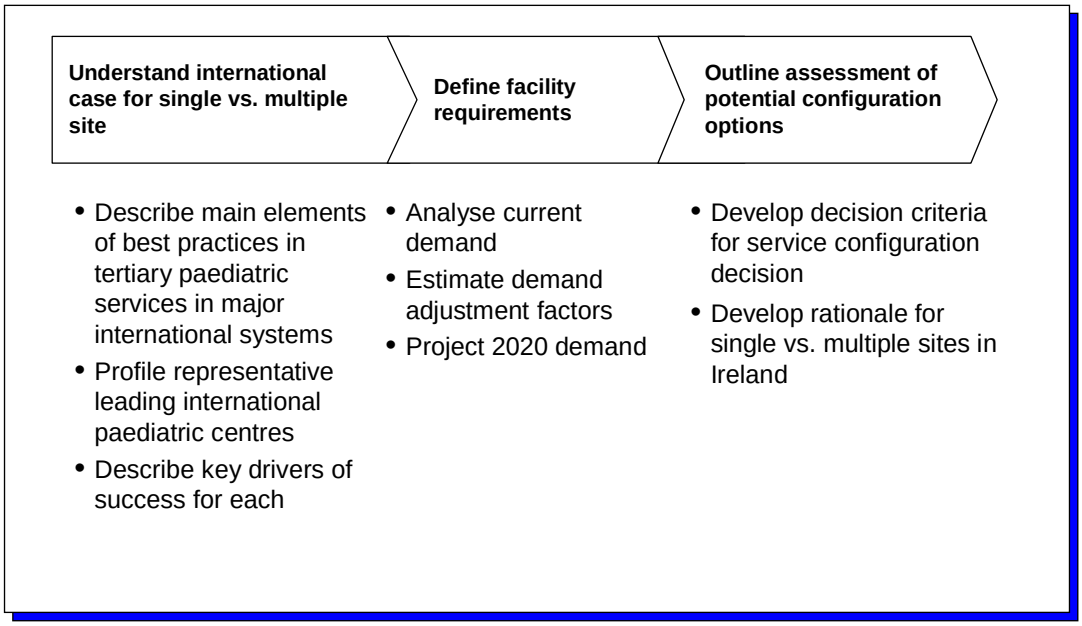
It is organised in 8 chapters:

Appendices

1. Overall approach

We split the work into two major elements: a broad look at international best practices and an estimation of required capacity in Ireland These come together in this report.

OVERALL APPROACH



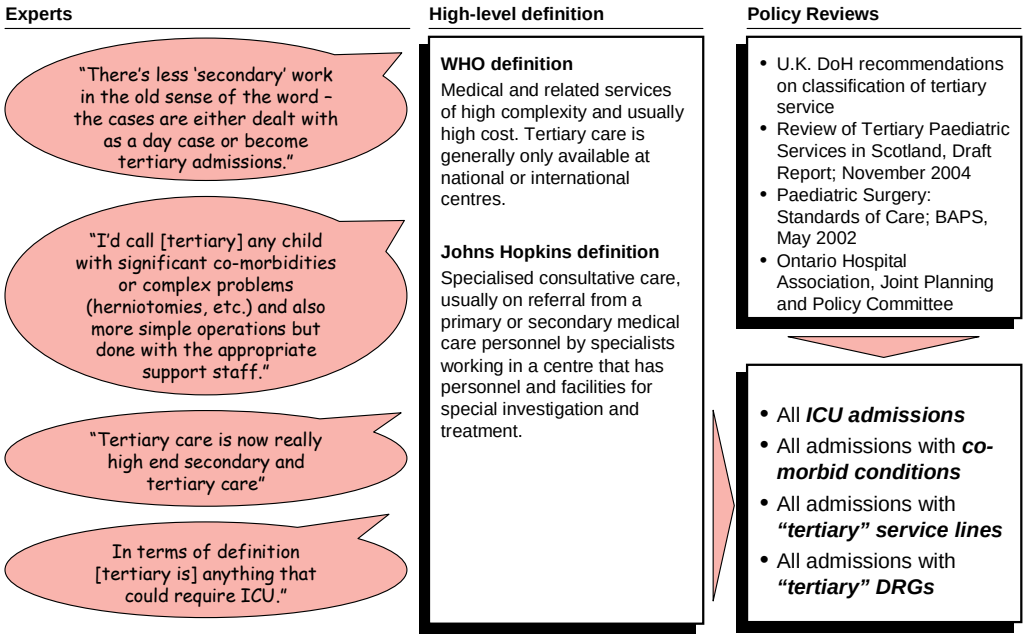
2. Approach to definition of tertiary paediatric services

It is important to define at the outset what we mean by tertiary services to ensure a consistent basis for our observations and recommendations. This is not simply a theoretical concern, since we want to ensure complete clarity in any wider debate on the content of this report. We[GC1] recognise from our broader experience that defining tertiary paediatric care is challenging as there is not a clear dividing line between what constitutes secondary and tertiary paediatric care (if there ever was one). Opinion in the literature and among experts on what "tertiary" includes varies from "complex kids" to "anything that's referred from another doctor" to "we don't count it that way, we just see all kids and treat them" to "secondary is a dying term – secondary is now what's dealt with on an outpatient basis and the stuff that comes in overnight is tertiary, more complex cases".

Definition becomes even harder at a more detailed level. The only country to provide specific guidelines is the UK– the Royal College of Paediatrics and Child Health has defined in detail what conditions unequivocally require tertiary care [appendix 4], noting that there are grey areas that need to be defined on a case by case judgement. What this means is that there is no current, exhaustive list of conditions that defines the extent of tertiary care. Whether a case is secondary or tertiary is a clinical judgement, which will vary by physician.

For the purposes of this report, we have taken two approaches to the definition of tertiary services. In our look at international best practices, we have taken a broad view which looks at what various systems have codified and gathers expert opinion on the split.

THERE IS NO 'BLACK-AND-WHITE' DEFINITION OF SECONDARY VERSUS TERTIARY CARE



Source: Interviews; WHO; Johns Hopkins University, literature, team analysis

When we move to estimating demand for tertiary services for Ireland, we have based our figures on Irish data and have applied a clear, clinically driven set of criteria to the Hospital Inpatient Enquiry (HIPE) data. This approach is our best application of the view developed in the review of international best practice. It is required to allow us work with real case data when estimating bed demand. When we apply this schema and designate encounters as 'tertiary' or 'secondary', the label is not intended or able to assess the appropriateness of location of treatment. Using this schema, we examined total length of stay (LOS) for intensive care unit (ICU) encounters in Dublin and non-Dublin centres. The very significant difference here (19 days in Dublin vs 4.5 days in non-Dublin centres) suggests that in aggregate clinically appropriate triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring. It is based on estimating the number of tertiary encounters in the HIPE database using three broad categories of encounters that should be considered tertiary, consistent with the literature and expert opinion:

- *"The critically ill patient"*: ICU patients
- *"Complex disease"*: 'Tertiary' Diagnosis Related Group (DRG) codes. A DRG was considered tertiary if: (1) it was classified as clearly tertiary by our reference sources or (2) if it was clinically indisputable that was tertiary in our experts' judgment.

- *"Simple disease in a complex patient"* Multiple sources support the notion that even common conditions in patients with pre-existing diseases should be treated as tertiary cases, as the patient benefits from a multidisciplinary approach. An example would be bronchiolitis in a child with congenital heart disease.

Our approach is described in more detail in chapter 5.

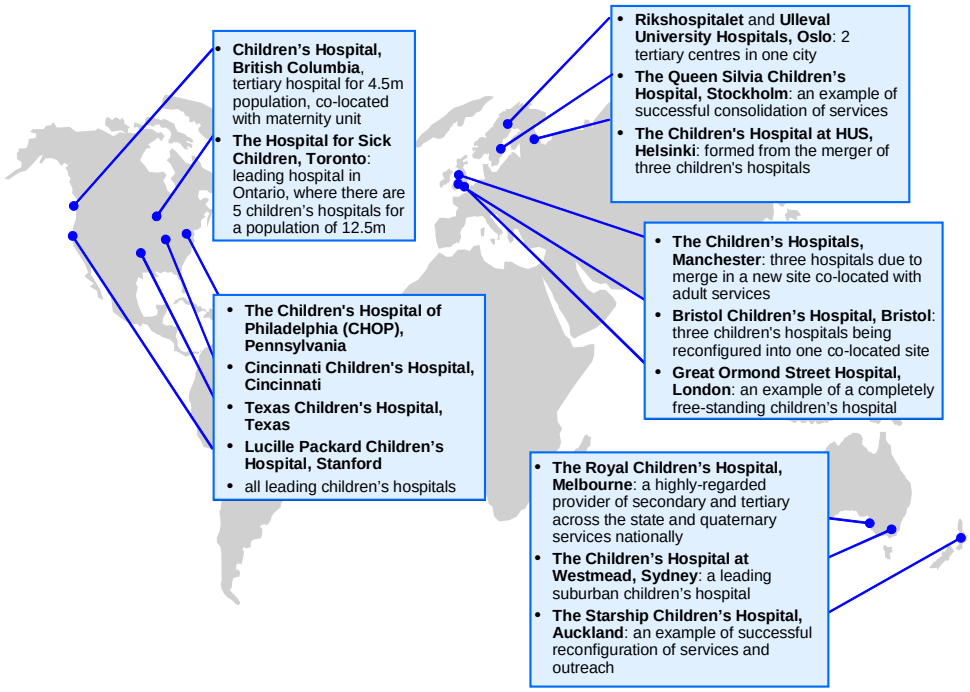
3. International best practices in delivery of tertiary paediatric services

This section summarises our findings on international best practices in the delivery of tertiary paediatric services. It covers: an overview of our primary sources; the evolution of working models for delivery of tertiary paediatric services over the last 40 years, including the major trends that have been driving the changes; what current best practices are; and how leading health care systems are configuring to deliver best practice.

PRIMARY SOURCES

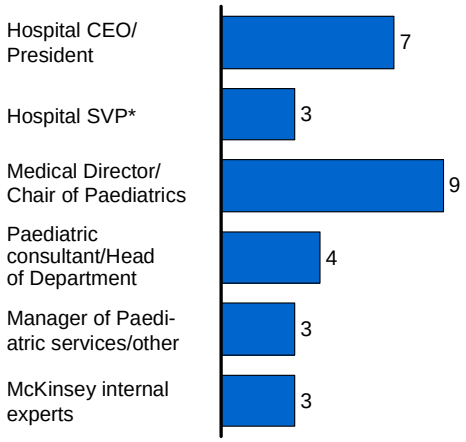
We examined in detail over 15 leading international tertiary care centres representing healthcare systems in Australia, Canada, Scandinavia, the UK, US and New Zealand. These systems were chosen to provide a range of insights: we looked at those where provision was managed/designed nationally; we focussed on populations/catchment areas similar to Ireland; and we sought to capture recent initiatives and innovations. We interviewed over 25 leading physicians and administrators in these centres and systems. We leveraged our network of partners and experts in Canada, Scandinavia, the UK and the US. And we conducted an extensive review of academic papers, professional body guidances and policy reports to understand the considerations and concerns that determine the configuration of best practice tertiary paediatric care.

HOSPITALS EXAMINED IN DEPTH PROVIDE A BROAD OVERVIEW OF BEST PRACTICES IN LEADING INTERNATIONAL SYSTEMS



WE HAVE INTERVIEWED PAEDIATRIC EXPERTS FROM AROUND THE WORLD

Interviewees by primary role
Total = 29

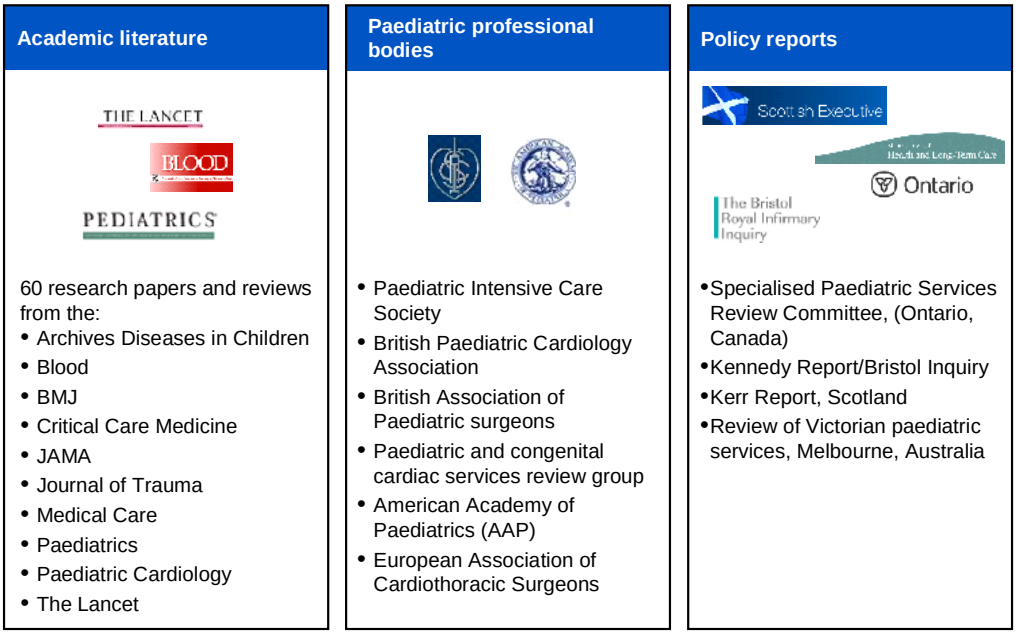


Interviewee location
Total = 29

Australasia	3
Canada	5
Scandinavia	5
U.K.	7
U.S.	9

* Senior Vice President

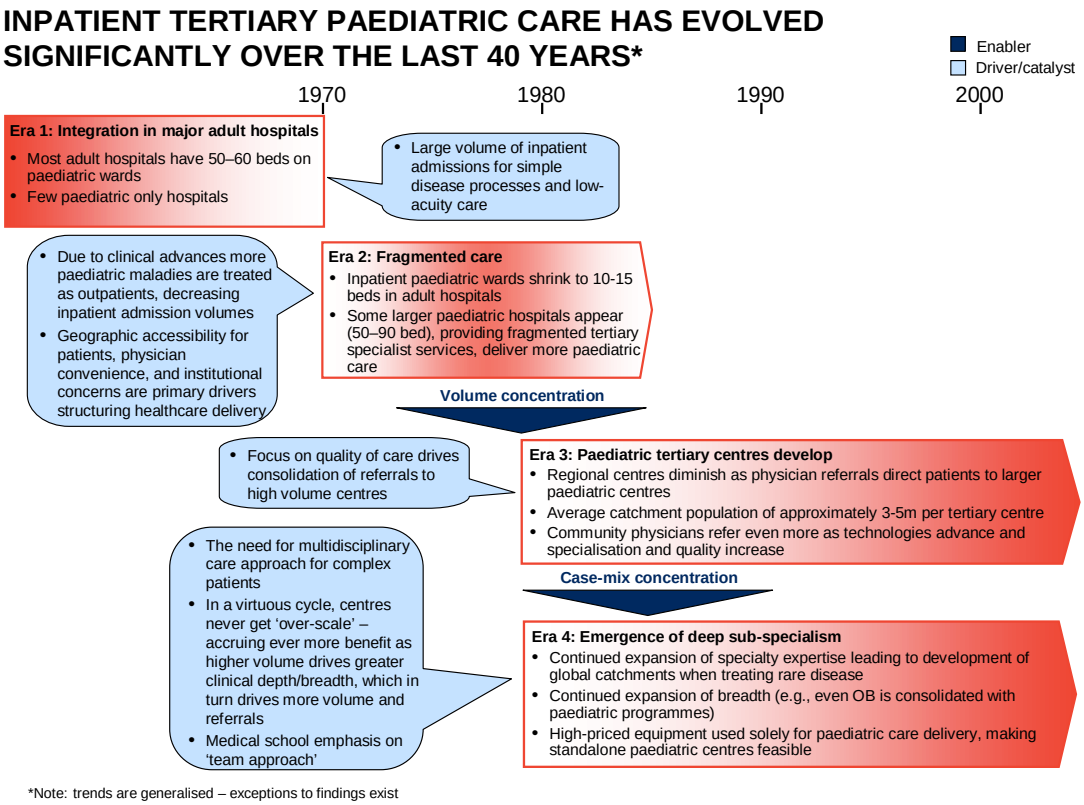
WE HAVE ALSO REVIEWED THE LITERATURE AND RELEVANT PROFESSIONAL BODY REPORTS



EVOLUTION OF WORKING MODELS IN DELIVERY OF TERTIARY PAEDIATRIC SERVICES

In reviewing any potential change, it is helpful to place the change in a historical context – it surfaces the main drivers of change and their effects.

Not surprisingly, inpatient paediatric service delivery has changed significantly over the last 40 years.



During this relatively short time, inpatient care has evolved from being primarily delivered in many adult hospitals (including a few notable exceptions in the UK and Ireland where there were standalone centres), to a still more devolved/local model. More recently, there has been a major shift towards concentrating cases at regional or national centres and, for the most complex cases, at centres with international catchments.

A number of key trends have driven this evolution:

¶ The emergence of a substantial body of evidence supporting the relationship between scale and improved outcomes. For paediatric care there are specific examples for cardiac care, ICU provision, oncology, transplant and anaesthetics (reference papers 1-7,9-13,17-28,30-31, 33, 35-36, 39, 43, 46-51, 56,58, appendix 3)

¶ Technological advances and the trend towards increased sub-specialisation that have allowed doctors to do more for sick children and to do it in the larger centres that have substantial capabilities. Literature (reference papers 60 and 61, appendix 3) and our experts highlighted this trend:

- "There is increasing use of sub specialists here mainly [because] more sophisticated work-ups/diagnostics are uncovering more pathology that may have previously gone undiscovered and [these findings] have to be referred for expert interpretation… and patients are more informed (about quality) and so either choose to go to tertiary centres direct or demand specialist referral"

¶ Greater concentration of services to ensure breadth of back-up (multiple specialties) and to render diagnostics and shared support (e.g Paediatric Intensive Care Unit - PICU) more affordable and more readily available.

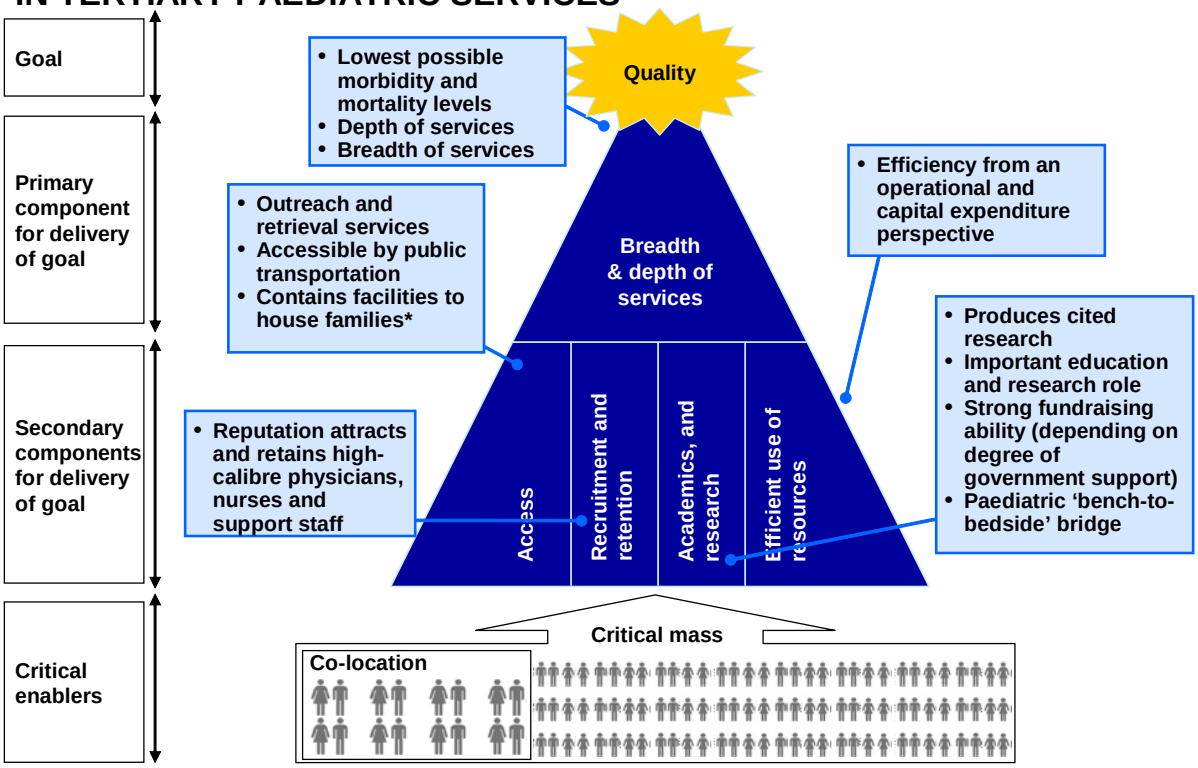
¶ Creation of more child friendly environments – for both patients and their families (Data from the National Association of Children's Hospitals and Related Institutes (NACHRI) in the US suggests that hospitals currently under construction are allowing up to double the amount of space per patient bed than legacy hospitals)

CURRENT BEST PRACTICES

The centres examined and experts consulted all painted a picture of optimal tertiary service being delivered as part of an integrated service configuration, with a tertiary centre as its focus. This tertiary centre provides tertiary services for its full catchment and secondary services for its local catchment. It is integrated with all secondary and community services in its catchment by referrals, outreach, and retrieval services.

All the centres examined have providing the highest quality of care (outcomes, patient experience) as their goal. What they do to achieve this goal breaks down into five components: breadth and depth of service (the most important); access; efficient use of resources; recruiting and retention; and teaching and research. The presence of quality is critically dependent on having genuine breadth and depth in sub specialist services - a 'critical mass'. Moreover, centres of excellence strive for and often achieve excellence across the other four components. To achieve sub specialist critical mass, tertiary centres virtually always (1) serve a large enough population to support a full complement of paediatric sub specialists, and (2) co-locate with an adult teaching hospital to access specialities that generally split between adult and paediatric patients (for example neurosurgery, transplant and increasingly cystic fibrosis and cardiac services) to facilitate clinical and academic 'cross-fertilization,' and to attract the top staff.

REQUIREMENTS TO DELIVER INTERNATIONAL BEST PRACTICE IN TERTIARY PAEDIATRIC SERVICES



* Does not include custodial or long-term facilities (e.g., for children with severe or profound disabilities)

Source: Literature, expert interviews, hospital profiles

We will now describe in more detail best practices concerning driving quality, each of the five components, and how critical mass and co-location impact them.

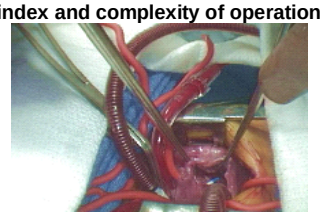
Driving quality

The key objective is to deliver world class quality. It is now strongly established across a number of specialities that quality is driven by volumes. For example, two internationally respected reports on outcomes in paediatric heart surgery have led to significant reconfiguration of tertiary paediatric cardiac services, with the goal of improving outcomes for children.

- The 1993 report of the Swedish National Board of Health into the configuration of Paediatric Heart Surgery led to the consolidation of services from 4 to 2 sites in Sweden.

CASE STUDY: MORTALITY REDUCTION IN SWEDEN FROM PAEDIATRIC HEART SURGERY CONSOLIDATION

The consolidation of Paediatric Heart Surgery (PHS) from 4 to 2 sites in 1993 led to a dramatic reduction in mortality rates, despite an increase in casemix index and complexity of operation



Previously, PHS was performed at 4 sites: Gothenburg, Lunn, Stockholm and Uppsala. There was consensus that consolidation of this service was required, but the means of consolidation were not agreed

The National Board of Health (NBH) conducted a survey which concluded that concentration would be beneficial.

After widespread discussion, the Board proposed consolidating to two sites rather than one, as they would still be "at scale" and this would increase competition and to minimise the effects of a sudden closure or part closure of one unit (for instance, by nosocomial infection or unforeseen absence of a key professional). The catchment size is still above scale.

Case study source: Paediatric Cadiol 21:353-357, 2000.

Approach

- Lack of universal support for the initial proposal to consolidate cardiac services prompted the NBH to commission a four year, in-depth study.
- The study demonstrated clear differences in 30-day mortality between the 4 sites, even when accounting for severity of cases. Its recommendations released in June 1992 re-emphasised centralising PHS onto one site.
- With this second recommendation, more thought/resource was put engaged in implementation.
- The NBH met with referring doctors at district general hospitals to explain the findings of the second report, emphasising the differences in mortality and reminding them to refer to centres that would cater for the best interests of their patients.

Effect

- An increase in referrals was seen in 1993 and become more marked in 1994. By 1995–97, the two sites accounted for 93% of all paediatric cardiac surgery.
- Over the same period, total surgical operations increased from 550 to 620 per year. New corrective procedures were offered (such as Norwood for hypoplastic left heart syndrome) and more frequent performance of specialised surgery (e.g., Fontane type) was enabled.
- Specialist, dedicated services were developed (anaesthetics, ICU, outreach, family rooms, etc.) which benefited surgical outcomes and resulted in better care for children and their parents.
- The two cardiac surgery sites have intensified national interest in the field, encouraging research, better training and greater fundraising.
- The two sites where surgical activity was stopped still perform catheterisations and pre-surgical workup.

Result

- Dramatic reduction in mortality from 9.5% to 1.9%, mostly over the first year of centralisation, despite an increase in complexity of cases.

¶ The Bristol Inquiry (2001) regarding high mortality rates for paediatric heart surgery has led to consolidation of services in Bristol and Manchester from three sites each to one tertiary centre for all services.

CASE STUDY: INCREASE IN MORTALITY IN BRISTOL, U.K. DUE TO LACK OF SCALE AND EXPERTISE

Greater scale and better expertise could have prevented the deaths of thirty-five infants in Bristol Hospital over a four year period in the 1990s.

The Bristol Royal Infirmary Inquiry

In 1969 the UK's Joint Cardiology Committee (JCC), Royal College of Physicians (RCP) and the Royal College of Surgeons of England (RCSE) reported the need for specialised cardiac centres.

The report led to nine hospitals being earmarked in the 1980s to provide paediatric cardiac surgery. Because Bristol was thought to be under-served by the other centres, Bristol was included in this list despite it not meeting the independent criteria laid out by the report.

Paediatric cardiac surgery in Bristol was undertaken by two surgeons whose main work was with adult cardiothoracic cases. By 1995 it became clear that the outcomes of cardiac surgery in Bristol were significantly worse than the other paediatric cardiac surgery centres and that it had failed to meet one of the absolute criteria that "the population [served by] each unit should be a minimum of 5 million."

Case study source: Bristol Inquiry, 2001, data sources – www.bristol-inquiry.org.uk/Documents/synthfigs.pdf, www.bristol-inquiry.org.uk/Documents/synthesis2.pdf

Problem

- Overall mortality rates in Bristol were far worse than the national average (14% versus 7%, for the period from 1991 to 1995)
- Over the same period, the difference in mortality rates of certain operations on infants under 90 days of age were even more pronounced: transposition/ switch was 58% in Bristol versus 10% nationally, and AVSD was 35% versus 8% for the rest of the country.
- There were 58 deaths over a four year period, 35 of which were classified as "excess" by the report.

Action

- The General Medical Council (GMC) struck off the two surgeons, as well as the hospital CEO, as he "should have prevented the surgeons undertaking the operations once the poor results became obvious".
- The GMC followed up by launching an investigation. A public enquiry was announced in 1999 which presented its recommendations in 2001.

Response

Selected recommendations from the public inquiry:

- "Where the interests of secured quality of care and the safety of patients require that these only be a small number of centres offering a specialist service, the requirements of quality and safety should prevail over considerations of ease of access. The NHS should assist families and carers with transport and accommodation costs".
- Children's acute hospital services should ideally be located in a children's hospital located as close as possible to an acute general hospital.
- Specialist services for children should be organised to provide the best available staff and facilities and thus the best outcomes.
- Health professionals including surgeons should hold a recognised qualification in caring for children, especially in intensive care units
- Units providing neonatal and infant cardiac surgery must have two surgeons doing 40–50 open-heart operations each per year.
- For very rare congenital heart conditions, surgery should be completed at a maximum of 2 national centres.

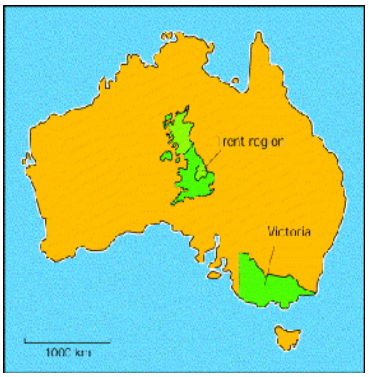
Similarly, reports on the benefits of scale in paediatric ICU (PICU) provision and in the breadth of sub specialties required to support PICU properly are driving consolidation to tertiary centres that have the breadth of sub-specialists required to provide safe levels of cover. Specifically:

- A 1997 case study in the Lancet described the improvement in mortality attributable to concentration of PICUs

CASE STUDY: MORTALITY REDUCTION IN AUSTRALIA FROM PAEDIATRIC ICU (PICU) CENTRALISATION

Mortality rates in Trent, U.K., where PICUs are fragmented, were nearly 50% higher than in Victoria, Australia, which has centralised PICU services.

If one assumed Trent was reflective of the rest of the country, centralisation of PICU services would have saved over 450 children's lives across the UK.



Case study source: Pearson G, Shann F, Barry P, Vyas J, Thomas D, Powell C etal. Should paediatric intensive care be centralised? Trent vs Victoria. *Lancet.* 1997; 349:1213–1217

Back-ground

- In 1997 PICU services in the U.K. were fragmented despite prior recommendations to centralise PICU facilities.
- Trent's PICUs (which served a population of about 4.2 million) were split across 19 sites, many only consisting of beds within an adult ICU.
- Victoria's PICUs (which served a population slightly larger than Trent's) were centralised in two main units at the Royal Children's Hospital (RCH) and the Monash Medical Centre.
- Victoria is much larger in area than Trent (see map). This means that 1 PICU covers 87,880 sq miles in Victoria compared with 3 PICUs covering 5,700 sq miles in Trent.
- PICUs in Victoria were staffed by full-time specialists in intensive care whereas those in Trent were rarely staffed by such specialists.

Results

- Mortality rates were significantly lower in Victoria's centralised system compared to Trent's fragmented sites (5.0% versus 7.3%).
- ALOS was also lower in Victoria compared to Trent (2.14 days versus 3.93 days).
- In Victoria, the majority of the very ill children were transferred to the PICU at RCH, which also accepted referrals from other states.
- The PICU at RCH achieved low ALOS and mortality by employing full-time, well-trained staff (four consultant paediatric intensivists and ten senior registrars each with a minimum of four years paediatric anaesthesia and nurses trained/training in paediatric intensive care). There were also two senior registrars on the unit 24/7.

- 2004 American Association of Pediatrics guidelines describe the level of sub-specialist and support back up required to safely run a PICU.

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- One of the experts we interviewed explained their practical implications this way, "Your intensivist needs to be able to call for a nephrology consult and an infectious diseases consult in his patient that has renal failure due to neutropenic sepsis… which is due to the chemo he's on for cancer. Oh - and that patient of course belongs to the oncologist in the first place."

These reports clearly imply a fundamental principle in configuring tertiary paediatric services: **providing critical mass of sub-specialist care is the most important factor in delivering best outcomes for patients**. Our experts were unequivocal on this point:

- "You cannot have two paediatric tertiary care centres focusing on different niches…I challenge you to find me an example of where that works"
- "We have two children's hospitals within two miles of each other. Neither of us is big enough to provide all the sub specialties, and children need more than one sub specialist, so it's hard to decide what to put where and what to share."
- "(We have) multiple hospitals (that) really struggle with critical mass. How can you provide a service with one specialist? You cannot. He cannot be on call 24/7 and not have holidays."

Key primary components of ability to deliver quality: breadth and depth of services

Full breadth of service is the most important component of delivering highest quality of care. It covers core medical, diagnostic and non-clinical patient support services.

- On the medical side, all leading centres should have a full complement of over 25 sub-specialities

TERTIARY HOSPITALS TEND TO PROVIDE SUB SPECIALISTS IN AT LEAST 27 "CORE" SUB SPECIALTIES

Medical

Anaesthetics
Cardiology
Endocrinology
General Medicine
Genetics
Haematology
Immunology
Infectious Diseases
Intensive care
Neonatology
Nephrology
Neurology
Oncology
Opthamology
Pathology
Radiology
Respiratory
Rheumatology
Microbiology & Clinical Chemistry

Surgical

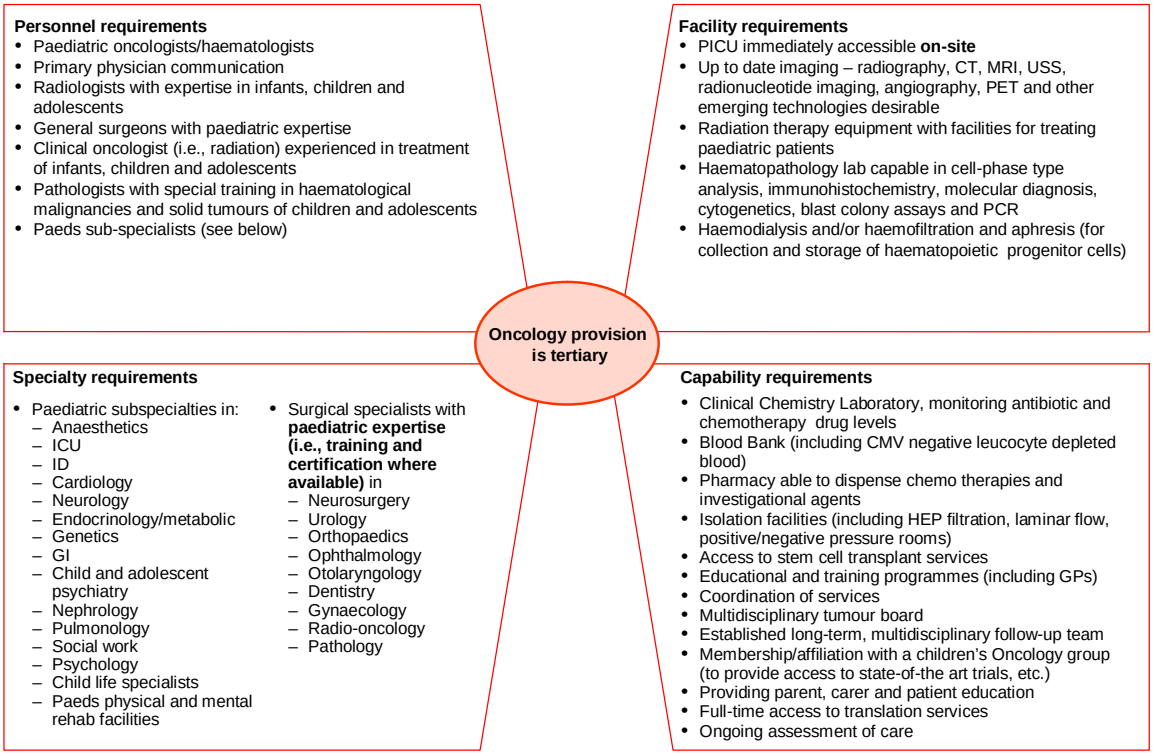
Cardiothoracic surgery
ENT surgery
Gastroenterology/GI/ hepatobiliary surgery
General surgery
Neurosurgery
Orthopaedic surgery
Transplant surgery
Urology

NOTE: Centres may have additional sub specialties, e.g., Dermatology, Burns, Plastics, Metabolic, Psychiatry, Clinical Pharmacology, Child development, Allergology etc.

As one of our experts put it, "children don't fit neatly into one sub-specialty. If you're going to treat one [complex child] you need to have the all the sub specialists and the whole multidisciplinary team there to provide care. Breadth with volume allows development of depth which is almost universally associated with improved outcomes. There is substantial evidence to support the benefits of breadth and depth in peer reviewed reports, for example in:

- Oncology: Pritchard, Stiller and Lennox, BMJ 1989 note improved outcomes for patients with Wilms's tumour when treated in a paediatric oncology centres; Stiller, Arch Dis Child 1988, states the importance of comprehensive, multi-disciplinary treatments as provided by tertiary paediatric centres in certain tumours; and Corrigan, Feig et al, Paediatrics 2004, describe the range of medical and surgical sub-specialties required for tertiary paediatric cancer care

ONCOLOGY DEPENDENCIES AS DETERMINED BY AMERICAN ACADEMY OF PAEDIATRICS PAPER



Source: Guidelines for paediatric cancer centres; Paediatrics. 2004; 113:1833–1835

- Cardiac: Hannan et al, Paediatrics 1998, demonstrate significant improvement in outcomes in centres with >100 cases per year compared to those with <100 cases per year (5.95% vs 8.26%); Lundstrom et al, Paediatric Cardiology 2000, mortality fell from 9.5 % to 1.9% despite increase in case mix complexity following consolidation of volumes between two centres
- Gastroenterology: Brian and Roberts, J Paediatric Surgery, 1996, significant reduction in morbidity for pyloric stenosis when treated by a paediatric surgeon compared to a general surgeon; Ein, Palder, Alton, Daneman, J Paediatric Surgery, 1994, Intussception - improved outcomes through concentrating interventional radiology expertise
- Anaesthesia: McNicol, Anaesthesia 1997, only specialist centres should do paediatric anaesthesia; Auroy et al, Anesth Analg 1997, case for

lower limit on paediatric anaesthesiology at >100 per year and ideally >200 cases per year

- ICU: Murdoch, Lancet 1993 (letter) PICU to run well needs full range of onsite paediatric specialties…cardiology, renal, neurology and surgery; Rosenberg, Moss, Paediatrics 2004, expand on Murdoch, to give the American Association of Pediatrics guidelines for sub specialist support for PICU
- General: Arul, Spicer, Arch Dis Child, 1998, meta analysis that notes improved outcomes in oncology, radiology, pathology and intensive care with higher volumes

The cases we examined all have capabilities across the full range of sub specialties, supported by a full complement of clinical facilities and non-clinical services:

¶ Leading centres typically have between 5-15 assigned operating theatres depending on the workload of the hospital, with 5 being the typical minimum dedicated to paediatrics. They all have direct access to MRI, CT, ultrasound, x-ray, nuclear radiology and interventional radiology. The degree to which they are able to utilise these resources fully varies. In the US, more children's hospitals have their own scanning equipment, whereas it is more usual for hospitals outside the US to have one to two dedicated machines and fulfil the remainder of their demand with shared adult facilities.

EQUIPMENT AND BEDS

	Avg. beds	Ratio beds to			ICU beds as % of total beds, percent			
	Count (range)	MRI	CT	Operating theatres	PICU	NICU	HDU	Total
Australasia, Canada, Scandinavia, U.K.	241 (195–263)	163* (118–254)	231* (120–314)	38* (24–49)	7 (5–10)	13 (11–16)	5 (3–7)	18 (15–22)
U.S.	344 (180–514)	87 (82–90)	95 (60–136)	23 (15–33)	13 (6–18)	22 (11–33)	8 (4–11)	40 (21–58)

* Many of these hospitals share facilities with adult services – these figures represent the child-dedicated service only
Note: PET scanner present in Texas, Cincinnati centres, HSC (Toronto) as reported by hospitals themselves

¶ Leading centres have significant non-clinical services designed to provide holistic care for the child and its family. These include:

- Education: schooling (not just for the patient, but also their siblings who may have to stay at the hospital with their parents); extensive play therapy, both for patients and siblings; and training facilities for the parents to prepare to care for the child at home. For example, Cincinnati has a family unit next to the NICU. The parents are able to care for their child in a simulated home environment, with all the support and help close at hand, making the transfer home much less traumatic
- Accommodation: all best practice hospitals ensure provision for the family and siblings of the patient, for example 14 of 16 hospitals have overnight accomodation for all the family; many have pull down beds next to children for both parents; and "Hospital Hotels" - where children not ill enough to require 24/7 nursing input in hospital can stay with their family. "Hospital hotels" are safer, more economic, and better emotionally for the patient and family

- Parent services: an emerging trend is to enable parents to keep in touch with their office by providing, for example, broadband internet connections next to the child's bed as was recently done in Cinncinnati

Leading centres are able to develop their capabilities to provide greater depth of care, which in turn allows them to carry out more complex procedures successfully. For example, after the consolidation of cardiac services in Sweden, the centralised service found not only that mortality decreased, but also that it was able to treat a greater mix of cases and provide more complex procedures than before, thanks to the increase in its depth of expertise.

Key secondary components of ability to deliver quality

Supporting breadth and depth of services, we see four additional components of the ability to deliver world class care: access; efficient use of resources, recruiting and retention; and academics and research.

¶ **Access**. For tertiary services, access should no longer be judged in terms of patient convenience. The Bristol Inquiry is clear on this point in relation to cardiac services, "quality and safety should prevail over ease of access". The recent focus of leading centres is to ensure that their links to secondary and community care are stronger. Leading centres achieve this by having integrated service delivery plans with relevant care providers in their catchments. The main components of integrated service delivery are effective outreach and retrieval services.

- **Outreach.** Outreach programmes provide tertiary paediatric clinics staffed by specialist consultants in areas beyond the tertiary paediatric centre's local catchment. Good outreach benefits patients and improves the quality of care. It gives patients access to the specialist they need to see; it improves the skills of local multidisciplinary teams; and it strengthens communications between Regional services and the centre. In addition to the outreach clinics themselves, support from the centre includes: interpreting emergency diagnostic tests; providing telephone consultations; and expediting essential transfers to the centre.

  Starship's cardiac outreach programme is an example of best practice. Their 5 paediatric cardiologists each do 22 day long outreach clinics per year. One of the cardiologists explained in practical terms how this builds expertise in the remote centre, "I have the consultant (from the Regional centre) in my clinic, and I'll spend time with the echocardiographer and teach him/her how to interpret scans, improve

views etc. We debated for a while as to whether we should take out our own echocardiographer, as it would be easier for us. We decided in the end it is better for the child if we train up the local staff. This way when they have a complex or sick child they can scan him/her and wire me the scans so that I can interpret them here".

- **Retrieval.** Providing timely access and transportation to a centralised PICU are critical capabilities of a best practice tertiary paediatric service. Both experts and the literature support using an emergency retrieval service, combining land and air (helicopter and fixed wing) transport, for the task. Research has uncovered no significant risks in retrieving very ill patients from Regional ICUs (often adult ICUs or paediatric HDUs) to a tertiary PICU. Indeed mortality scores before transfer are worse than on arrival at the tertiary unit, according to Britto, Nadell, Machonichie, Levin and Habibi, BMJ 1995 (reference 15 in appendix 3). The range of retrievals per year varied between the systems we have data for. For example, Bristol and New Zealand, each with catchments of around 4 million, had about 150 and 300 retrievals respectively.

- Despite this concentration on access for patients who are in genuine need of tertiary services, accessibility is still very important for all patients and staff

¶ **Efficient use of resources.** An important consideration in developing any hospital is ensuring that it is configured to deliver value for money. This applies to efficient utilisation of staff, facilities, and diagnostic/therapeutic equipment, and to ensuring that where possible services are not duplicated or provided sub scale.

- **Staff**. In practical terms, this means having sufficient activity levels to support the extensive sub-specialist capabilities that are required to deliver highest quality care. Frequently this means having sufficient volume to support 24/7 consultant cover. Ensuring the centre provides secondary care for a significant local catchment is a means of achieving this.

- **Facilities**. Maintaining bed flexibility is key to efficient use of facilities. As our experts said, "there is no such thing as a dedicated bed in a children's hospital". This is particularly important in paediatric care, where peak winter demand with respiratory ailments gives way to elective surgeries in the summer. Similarly, the ability to interchange day case and full time beds is important as the trend towards day cases

increases. Finally, it is likely that the proportion of ICU beds will rise significantly in the near future, so it is important to incorporate this likelihood in any facility design.

- **Diagnostic and therapeutic equipment**. Clearly there are economies of scale in equipment utilisation and capital expenditure – particularly in the event of co-location with an adult hospital

- **Services**. Many of the basic laboratory, pharmacy, patient administration and other services, such as catering, are more effectively provided 'at scale' within a large paediatric centre. There are further benefits to be captured through co-location. However, the merits of sharing need to be examined case by case to ensure proper understanding of the needs of the Children's Hospital.

¶ **Recruiting and retention.** Successful centres place a great emphasis on recruiting and retaining outstanding staff. This is especially important in paediatric medicine where the opportunity to contribute to exciting work is a powerful motivator. Looking forward, this will be critical given the ongoing shortages of key personnel (for example the well observed shortage of nurses in the UK and the US) and the continuing requirement to develop more specialised multi-disciplinary teams.

The profile of the centre (quality, teaching, research, 'brand') plays an important role in recruiting and retention. It makes the centre more attractive for recruiting, and generates broader opportunities for development and career progression, and for creating new specialist roles. Our interviewees illustrated this point:

- "I attract them to the "university" brand, then they come and work for me in the children's hospital. Once they're part of this system they don't look to leave"

- "There is an atmosphere on a big campus that is enormously powerful in attracting people – everyone from the physician to the respiratory therapist."

- "It's a package. You've got to provide the research and development opportunities if you're going to attract the best staff, and if you don't keep your promise once they're here they'll leave again. The development opportunities don't apply just to doctors or nurses, you know."

¶ **Teaching and research.** Teaching and research are frequently core parts of the mission of any academic teaching centre. In the case of integrated tertiary services, the teaching role is particularly important. All of the centres we examined were affiliated with a medical school, and often co-located with the school itself. "We train the doctors, nurses and allied health professionals of the future, if we don't get that right then who will?"

There was a strong belief among our experts that a tertiary paediatric centre has an obligation to further clinical research. Indeed, the prospect of contributing to research that advances the treatment of children's diseases is an important motivator for the leading clinicians any centre wants to attract. The centres we profiled all emphasise their research activities.

4. Implications of best practices for the configuration of international tertiary paediatric services

The evidence above provides a strong basis for an "at scale" tertiary centre at the heart of an integrated service. We also noted above the fundamental principle that: **providing critical mass of sub-specialist care is the most important factor in delivering best outcomes for patients**. This raises the questions: what population do you need to support a sub specialist critical mass necessary for an integrated tertiary paediatric service with one tertiary care hospital at its core? How should one think about co-location to enhance access to adult sub specialties with paediatrics components? And how do you optimise the overall configuration of tertiary services on a national level?

- **Population required for a single integrated tertiary service.** We found that the minimum effective catchment was in the region of 3.5-5 million. The Helsinki, Vancouver, Cincinnati, Bristol, and Manchester centres all support this. We also acknowledge that some centres are not at this scale, (e.g., Oslo). In these cases a number of local and specific factors explain the current configuration - though all experts would recommend one centre given a clean sheet.

RANGE OF BED SIZES AND POPULATION CATCHMENTS FOR LEADING CENTRES

	Hospital	Effective catchment, m	Reported beds	Notes
Australasia	• Westmead	4.2	339	• Additional specialist services provided at Sydney Children's Hospital, Randwick
	• Starship	5.0	200	• Also provides services to children of the Pacific area (population 1m)
	• RCH, Melbourne	9.0	250	• Monash Medical centre in Melbourne also provides some lower end tertiary care
Canada	• HSC, Toronto	12.5***	300	• Four other children's and acute hospital also serve this catchment • Ontario has 156 beds, London 58 beds, Kingston and Hamilton <80 beds • Only centre for neonatal cardiac surgery, and one of two offering paediatric cardiac surgery
	• BCCH	4.5	142	• Only tertiary children's hospital in British Columbia
Scandinavia	• HUS	5.2	293	• Formed from consolidation of 3 hospitals. A degree of tertiary care is provided in the community
	• Queen Silvia's	4.7**	215	• Care in Sweden is still provided by 4 centres, however key tertiary care (e.g., cardiac surgery) has been consolidated to two sites
	• Ulleval	<2	120	• Example of two sub-scale hospitals. Both Rikshospitalet and Ulleval take tertiary referrals for Norway, however there is a network of "National Competency Centres" whereby a network of 3 other regional paediatric hospitals have developed areas of expertise.
	• Rikshospitalet	<2	150*	
U.K.	• Bristol	3.5–4.0	176	• In the process of consolidating the services provided across 3 hospitals onto one site, some secondary services in the community
	• Manchester	4.0-5.0	393	• Due to consolidate children's services from 3 hospitals onto one site in 2009, some secondary services to be provided across Manchester, but much to be centralised
	• Great Ormond Street Hospital	>7.4	314	• London (7.4m) provides 47% of inpatients, so catchment is larger • Recently agreed a partnership with North Middlesex and Whittington hospitals for secondary care provision
	• Evelina	<7.4***	140	• London has other tertiary paediatric services. Evelina catchment SE England plus part of London
U.S.	• Lucile Packard	10	180	• Secondary and tertiary services available at 160-bed UCSF in the same city. High surgical to medical ratio will impact on bed utilisation
	• Texas CH	4.6	464	• 90% of the local Houston catchment, plus patients from all Texas
	• CHOP	10	514	• Pennsylvania market. Other children from U.S. and world
	• Cincinnati	3.5	408	• Local Cincinati and Dayton catchment, 20% patients from outside this catchment

* Includes 50 beds in 'paediatric hospital' and the 100 beds in bays of adult wards in Rikshopsitalet
** 50% of Swedish population. There are 4 children hospitals in Sweden, but only 2 provide cardiac surgery, and only 3 provide dedicated facilities
*** Extended 'quaternary' catchment
Source: CEO interviews; hospital annual reports and homepages; team analysis

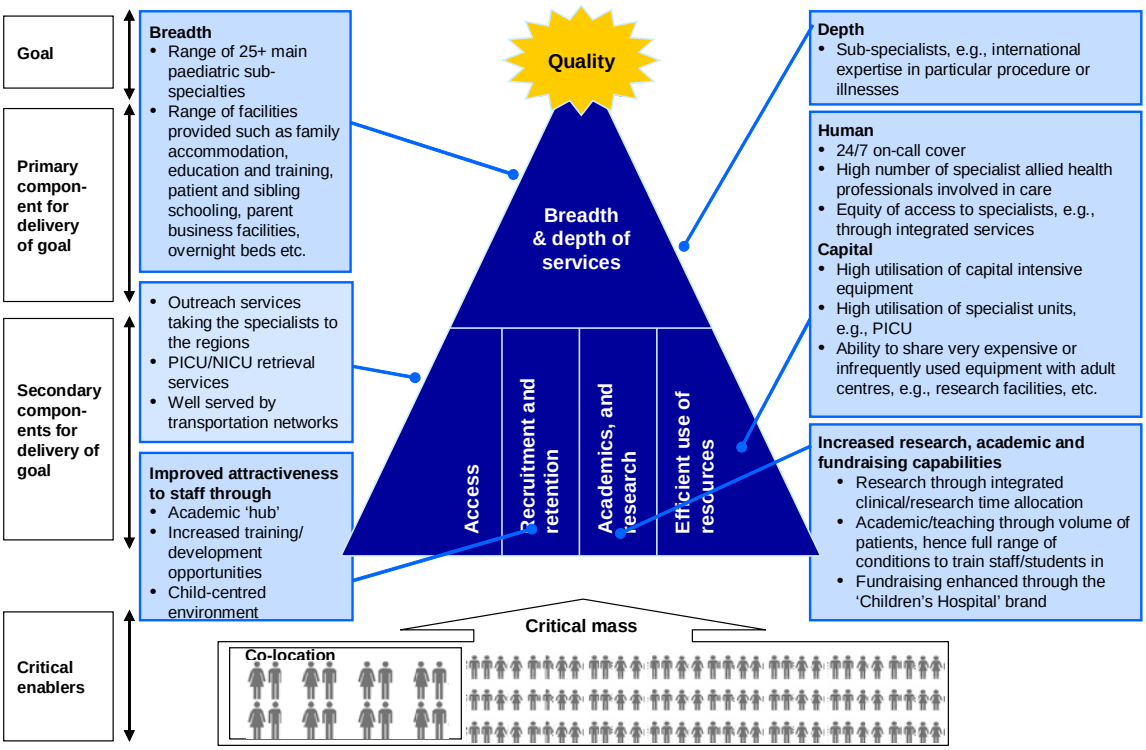
We consider this the minimum critical mass for the catchment of a tertiary paediatric service to support a full service of paediatric sub specialists. All bar two of our interviewees confirmed that a 4 million population could only support one tertiary centre. "You can't really be at scale for tertiary under 3m catchment population; even at that there are some areas you're still struggling at". One considered that "If there were two large populations far from each other, you could possibly justify a second smaller centre in one of them, but not both in the same city". The Bristol Inquiry is more specific. For cardiac surgery, one of the absolute criteria is that "the population served by each unit should be a minimum of 5 million".

Tertiary catchment is only one part of achieving scale for these centres. Pure tertiary cases typically constitute a minority component of total paediatric volume, and secondary cases are an essential part of

maintaining scale. It is hard to estimate the secondary/tertiary split for the centres we have profiled. While they have between 180 and 500 utilised beds, the secondary element depends on the extent of the referral network, the development of primary and community services and the number of secondary beds in the local catchment.

¶ **Optimising service configuration.** At its apex, an integrated system has a world class tertiary centre. The attributes of such centres are summarised against our model:

REQUIREMENTS TO DELIVER BEST PRACTICE IN TERTIARY PAEDIATRIC SERVICES



Source: Literature, expert interviews, hospital profiles

¶ A key additional question is whether leading centres are standalone or co-located. Reflecting the view of our experts, we defined co-location as the children's facility being within a practical walking distance; as one expert put it, "If you're not within walking distance of the adult hospital, you're not co-located."

- **Standalone**: A hospital that is physically/ geographically isolated from adult services.

- **Co-located**: A hospital that is located in its own building, but that is adjacent to an adult hospital. Most have covered walkways connecting the children and adult services. Budget and governance may be integrated or separate.

The hospitals and experts cite many benefits from co-locations that support sub specialty critical mass. The Bristol Inquiry found co-location to be necessary to support quality of care. Its recommendation 178 states that, *"Children's acute hospital services should ideally be located in a children's hospital, which should be physically as close as possible to an acute general hospital"*. The Scottish Review of Paediatric Services 2004 specified that, *"Children's specialist acute services should be co-located with adult, maternity and neonatal services"*. Of 17 hospitals we examined, 15 were co-located with adult services, one was co-located with women's services only, and only one – Great Ormond Street was entirely standalone.

VIRTUALLY ALL CHILDREN'S HOSPITALS EXAMINED ARE CO-LOCATED. DEGREE OF INTEGRATION WITH ADULT SERVICES VARIES

	Hospital	Co-located	Adult Hospital	Med school affiliation	Notes on co-location
Austra-lasia	• Westmead CH	✓	• Westmead Hospital	• Sydney University and West Sydney University	• Physically linked by overhead walkways. Actively mention as one of their goals is to work more closely with Westmead Hospital
	• Starship	✓	• Auckland District Hospital	• Auckland University	• Physically linked by tunnels, shared facilities with adult centre. University adjacent
	• RCH, Melbourne	✓	• Royal Melbourne Hospital	• Melbourne University	• Royal Melbourne Hospital is 300m across the road, and Melbourne University is a further 300m away
Canada	• HSC, Toronto	✓	• Toronto General Hospital • Mount Sinai Women's Hospital	• Toronto University	• Separate buildings within same half-block
	• British Columbia CH	✓ Maternity only	• BC **Women's** hospital and healthcare	• British Columbia University	• No general adult facilities onsite, only women's/maternity
Scandi-navia	• HUS	✓	• Helsinki University Central Hospital	• Helsinki University	• Some sharing of laboratories etc. with adult hospital
	• Queen Silvia's	✓	• Ostra Sjukhuset Hospital	• Salgrenska University onsite	• Shared laboratory facilities. Separated radiology easy walk between the two buildings
	• Rikshos-pitalet	✓	• Rikshospitalet Adult	• Oslo University	• Children also share dedicated bays on adult wards as well as all the labs and radiology resources
	• Ulleval	✓	• Ulleval Adult Hospital	• Ulleval University	• Shared operating theatres, A&E, laboratories, etc.
U.K.	• Bristol	✓	• Bristol Royal Infirmary	• Bristol University	• Located on same city centre campus. A combination of walkways and dedicated ambulance services for neonates cover the distance of up to 100m between buildings
	• Manchester	✓	• Manchester Royal Infirmary	• Manchester University	• Currently 3 separate sites, due to consolidate to one site co-located with Manchester Royal Infirmary and Manchester University Medical School
	• Evelina	✓	• Guys & St.Thomas (GST)	• Guys & St. Thomas's Medical School	• On the same site as St. Thomas', integrated budget, governance, lab, and back office functions
	• Gt Ormond St. Hospital (GOSH)	X	• Nil	• University College, London	• No physical co-location. 40 of their consultants have shared positions in adult hospitals as well as GOSH
U.S.	• Lucile Packard	✓	• Stanford Hospital	• Stanford Medical School	• Situated on the same campus as adult and medical school facilities. Separate budget. Self-contained radiology etc. OB services located in adult hospital but run by children's
	• Texas CH	✓	• St. Luke's Episcopal Hospital	• Texas medical school	• Free standing governance, budget, and equipment, but connected with tunnels to the OB services at St. Lukes Episcopal. On campus with Texas University
	• CHOP	✓	• Pennsylvania University Hospital	• Pennsylvania University	• "Stand alone" governance, budget and most equipment etc., On the same campus as university and adult hospital. New initiative to share proton beam with adult centre
	• Cincinnati	✓	• University Cincinnati Hospital/ Medical Centre	• Cincinnati University	• Situated on the same campus as adult centre and medical school. High risk maternity at the adult centre, cared for by children's hospital staff. No sharing of equipment/laboratories

Source: Interviews; hospital annual reports and homepages; team analysis

- There are benefits from co-location in broadening services, making efficient use of resources and in teaching and research.
  - **Breadth of services**. A tertiary paediatric hospital co-located with an adult centre can share staff in those sub-specialties for which the caseload in the children's service does not by itself warrant a paediatric-only service, e.g., transplant surgery, neurosurgery and certain specialised orthopaedic surgeries (e.g. hand). This can lead to improved outcomes. For example, Edwards, Roberts , McBride, Schulak and Hunsicker, N. Engl J Med, 1999, noted in liver transplant the relationship between volume and lower mortality. They observed that low volume centres that were affiliated with high volume centres (e.g., paediatric programmes) had similar results to those of high volume centres.
  - Co-location also allows for enhanced patient care for chronic disease that traverse paediatric to adult care (e.g. for cystic fibrosis patients). These occur in various contexts, from consultants with joint accreditation in paediatrics and adult care who manage the care of children from childhood through adulthood, to clinics involving both paediatric and adult doctors as a child grows older. These centres typically also have the critical mass to develop distinctive adolescent-care programs
  - **Efficient use of resources**. As described above, co-location with an adult hospital enables the children's centre to share equipment and run services with operating cost benefits.
  - **Teaching and research**. Co-location offers more opportunities for professional collaboration and continuing medical education (CME), e.g. joint conferences, facilitating clinical 'cross fertilisation' between adult and paediatric consultants. One of our experts commented, "I'm a paediatric cardiologist, I've [a lot] in common … with an adult cardiologist ….I can discuss cases or general approaches or new advances". This opportunity for collaboration is an important factor in attracting top talent.
- Our experience suggests it is important to distinguish between co-location and integration. All hospitals emphasise the importance of maintaining an independent identity for the paediatric hospital. They make different choices about how far to integrate with their partner hospital concerning some issues, in particular: the mode of physical connection (e.g. tunnel, bridge); the degree of governance integration (separate or common Board/

management/budget); how many services are shared; and whether training and education programmes are integrated. However, while the centres we profiled had chosen variations on all of these issues, they agreed on two important pieces of advice for any children's hospital co-located with an adult hospital: keep separate budgets – children's funding priorities can lose out next to more powerful adult interests (children don't vote); and maintain a separate children's brand – this is important for building a child focussed culture and for attracting private funds.

¶ International experience shows that it is important to weigh a decision to co-locate against pragmatic considerations, including: space and quality of access to potential sites; cultural and managerial fit with the adult hospital; and the quality of managed service provision on the adult site. These notwithstanding, most recent build decisions are opting for co-location.

NEW BUILD CONFIGURATIONS: GENERAL TRENDS

Country	Hospital	Date build complete	Size Beds	Co-located	Proportion Single rooms	Notes
U.K.	Bristol	2001	176	Y	40%	• New facility built in centre of town campus with adult facilities
U.K.	Manchester	2009	388–393	Y	n/a	• Building integrated adult/maternity/children's and eye hospital on the Manchester Royal Infirmary site
U.K.	Evelina, London	2005	140	Y	<25%	• Built near train/underground links lines and next to adult services
NZ	Starship, Auckland	1991	200	Y	n/a	• Built in the grounds of Auckland hospital
U.S.	Vanderbilt Atlanta	2004	216	Y	100%	• Increase in beds over old hospital by 20%. Additional facilities such as family business centres, laundry rooms and breast feeding rooms added
U.S.	Pittsburgh	2007	235	Y	100%	• 28 NICU and 48 PICU beds, 28 observation beds added • Rooms 80% larger than before
Norway	Ulleval, Oslo	~1998	120	Y	n/a	• Sub-scale hospitals built due to budgetary difficulties
Norway	Rikhosp-italet, Oslo	~1998	55 +100**	Y	n/a	

*Patient stay beds (NB pre-op and post-op areas are open bays)
**55 beds in "Paediatric cetnre" plus approx 100 beds on children's bays in adult wards
Note: Health Building Note 23 (HBN) recommended in 1984 (and updated in '05) in all new-build children's hospitals that 40% beds be in single rooms (HBNs are developed by NHS and professional building/architectural bodies)

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Leading international paediatric services provide a clear picture of the configuration of an 'optimal' paediatric service for a population of up to 5 million:

- A single tertiary centre (also providing secondary care needs for its local catchment)
- Co-located with an adult teaching hospital
- Linked with other paediatric regional centres, within the context of a clearly defined integrated service
- Additional considerations included accessibility to public transport and roads, and space to expand for research and clinical needs

These single site criteria reflect the current (or planned) pattern of provision in 14 of the 17 metropolitan areas we look at in depth. For the remainder, commentators acknowledge the ideal would be a single site, but recognised the practical challenges of legacy institutions, multiple stakeholders and institutional pride.

5. Current and projected demand for tertiary paediatrics in Ireland

This section lays out our understanding of current and projected national tertiary demand, together with the secondary needs of Dublin (applying the methodology we developed at a high level earlier). We take some pains to lay out our methodology and assumptions to ensure full transparency.

CURRENT NEEDS

We first try to establish a common basis of understanding for the current analysis. This covers our scoping, establishing our methodology for defining tertiary care and how this translates into current demand. Then, we discuss our methodology for establishing secondary demand in Dublin and what this means for current needs.

Based on the approach to be outlined, we have found that current bed needs are:

- National tertiary care: 32 ICU, 199 non-ICU

- Dublin secondary care: 188 non-ICU, 31 day-beds

Scoping and estimation methodology for tertiary care

As noted in the beginning of this report, there is no single 'best' approach to defining patient encounters as tertiary. Here we have developed a schema that classifies cases as tertiary based on the diagnosis of each case, rather than according to where they were referred for treatment, for three reasons.

- Defining tertiary cases on a referral basis misses tertiary cases that are never referred beyond the hospital of admission
- A classification based on diagnosis allows estimates of demand for ICU and floor beds, and by length of stay (LOS)
- It also provides a standardized, transparent methodology with which to classify >120,000 patient encounters (approximately 79K inpatient and 41K day-case encounters) within the Hospital Inpatient Enquiry 2003 database

We believe that a system based on diagnosis gives a good overall representation of the tertiary/secondary split, and provides a transparent, robust basis for estimating bed requirements.

The data applied here came from the Hospital Inpatient Enquiry (HIPE) data collected by the HIPE & National Perinatal Reporting System (NPRS) Unit of the Economic and Social Research Institute. Additional data were provided by the National Hospital's Office, HSE. The HIPE 2003 dataset, the most current validated dataset at the time of the study, contains all inpatients and day-case discharge encounters for 2003. Analysis of HIPE data was performed in conjunction with the Population Health Directorate, HSE.

We developed a process to classify 2003 discharges retrospectively as either tertiary or secondary using data from the HIPE 2003 database. We will discuss our classification methodology to ensure full transparency.

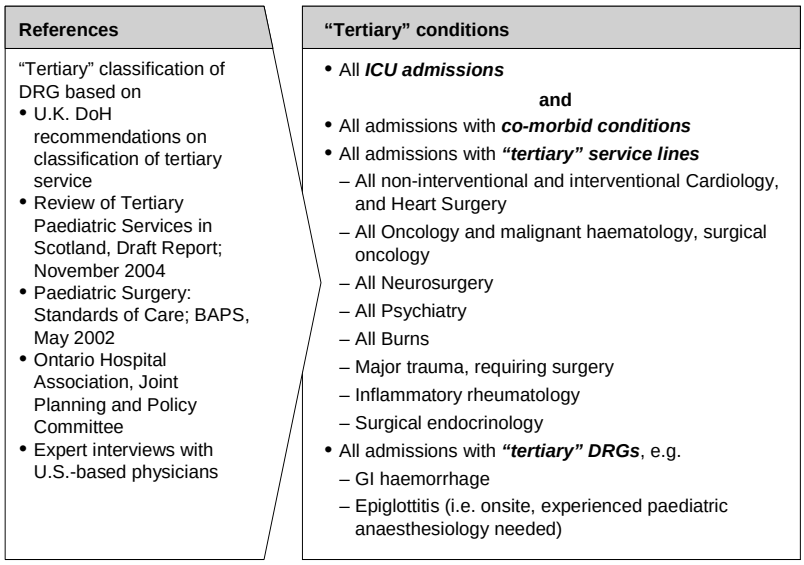
Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

¶ **Step 1:** We captured a first estimate of the number of tertiary encounters in the database using three broad categories of encounters that should be considered tertiary, consistent with the literature and expert opinion:

- *"The critically ill patient"*: ICU patients are among the most complex and critically ill patients and therefore benefit the most from a multidisciplinary, subspecialty approach. To capture this type of case, we considered a patient encounter 'tertiary' if the patient was admitted to the ICU or PICU at any time during their encounter.
- *"Complex disease"* We developed a list of 'tertiary' Diagnosis Related Group (DRG) codes. A DRG was considered tertiary if: (1) it was classified as clearly tertiary by our reference sources or (2) if it was clinically indisputable that was tertiary in our experts' judgment. For example, "DRG 481: Bone Marrow Transplant" was considered both 'tertiary' from a common-sense standpoint, as well as from our references.
- *"Simple disease in a complex patient"* Multiple sources support the notion that even common conditions in patients with pre-existing diseases should be treated as tertiary cases, as the patient benefits from a multidisciplinary approach. An example would be bronchiolitis in a child with congenital heart disease. Therefore, we considered a DRG to be tertiary if it contained a flag for the presence of a comorbid condition.

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

APPROACH TO CLASSIFYING DRG CODES AS TERTIARY



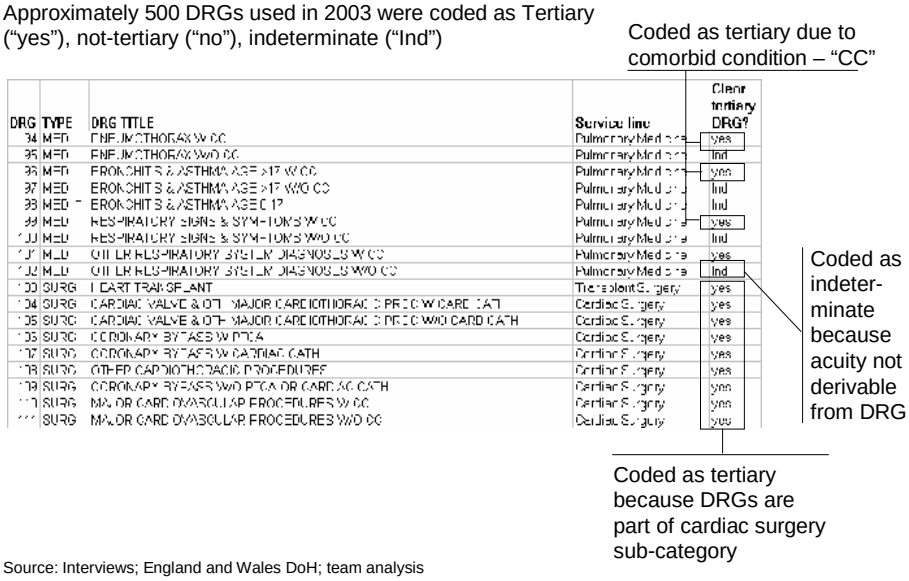
Source: Reports (above); team analysis

¶ **Step 2:** If an encounter was still ambiguous after assessment against these criteria (e.g. an encounter coded as "DRG 98: Bronchitis and Asthma, age 0-17" that was not admitted to the ICU), the encounter was classified as 'secondary care'. For this reason, the classification schema will tend to under-record tertiary DRGs. This effect is mitigated, however, by the fact that such an admission would be classified as 'tertiary' if it were acute enough to involve ICU care. In addition, classifying an encounter as 'tertiary' because a comorbid condition is present – a label that implies a level of acuteness or complexity that may not in fact be present– would over-record 'tertiary' encounters in a countervailing fashion. We preferred to be conservative.

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

EXAMPLE: CLASSIFYING DRGS AS TERTIARY OR NOT

Approximately 500 DRGs used in 2003 were coded as Tertiary ("yes"), not-tertiary ("no"), indeterminate ("Ind")



Source: Interviews; England and Wales DoH; team analysis

In addition, we classified ~20,000 ICD-9 (International Classification of Disease, Ninth Revision) procedure and diagnostic codes as tertiary or not to provide an alternative "sanity check" of our estimates. This approach came within 1% of that produced by the DRG approach.

¶ **Step 3:** We excluded a number of encounters that would not normally be treated by a tertiary paediatric centre in Ireland, namely certain NICU and neonatal volumes and certain paediatric volumes at specialist hospitals.

- **Exclusion of Dublin-based Maternity NICU volume, and Non-Dublin neonatal volume.** Care of non-surgical infant encounters (i.e. NICU infants) is provided primarily by Dublin-based maternity hospitals, as well as Non-Dublin adult hospitals. These facilities have capabilities to care for NICU patients. Therefore, this report does not assume that substantial neonatal volume will be diverted or transferred from maternity hospitals or Non-Dublin maternity wards in the future, beyond the current proportions arising from surgical transfers.

  We therefore excluded the following paediatric encounters from further analysis: all encounters occurring at Dublin-based maternity hospitals; all neonatal encounters (DRG 385 – 390) occurring at Non-Dublin

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

hospitals. Neonatal encounters occurring at Dublin-based paediatric hospitals are included in further analysis.

- **Exclusion of specialty hospital volume.** Some 0.6% of all 2003 paediatric encounters occurred at a specialty hospital. A specialty hospital is defined as having a singular clinical emphasis (e.g. orthopaedics only, ENT only, etc), and typically has a mixed adult and paediatric population. International best practice suggests that in the setting of single specialty care delivery with appropriate volume, commingling of adult and children's populations does not adversely affect clinical quality. Therefore, this minute specialty-hospital volume was excluded from further analysis.

- **Private hospital encounters.** These encounters are not captured in the HIPE database and therefore could not be analysed.

¶ **Step 4:** We defined what age group to define as paediatrics. Experts and the literature describe various age cut-offs to define a paediatric case, typically < 16 years old. We analysed all discharges in the HIPE 2003 database and found that within the Dublin population, patients between the ages of 0 - 16 were more likely to be admitted to a paediatric hospital than an adult hospital. At age 16 and older, the situation reversed: they were more likely to get admitted to an adult hospital. This implied, from a clinical perspective, patients age of 16 and above were generally treated as adults. Because such discharges would confound our clinical classification of paediatric encounters, and patients beyond the age 16 accounted for no more than 5% of total discharges, the age range chosen to analyse was 0 to <16.

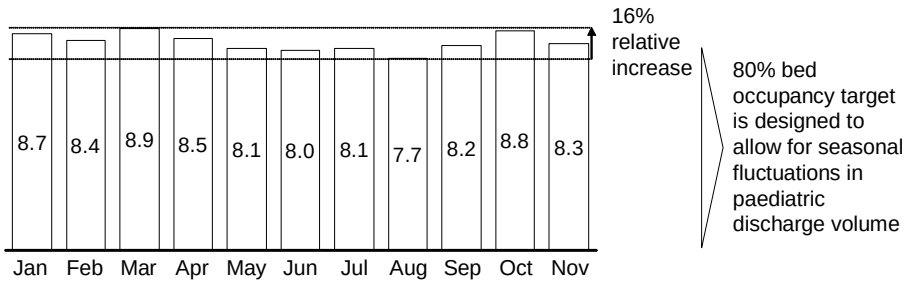
¶ **Step 5:** International best practice targets an average occupancy rate of 85% for adult hospitals. However, paediatric discharges have more seasonal variation in admission volume: the relative monthly variance in paediatric discharges in Ireland in 2003 was 16%. Therefore, in calculating bed-needs going forward, we target an average occupancy rate 80%

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

PAEDIATRIC DISCHARGES VOLUMES MAY VARY BY UP TO 16% DEPENDING ON THE MONTH

Ireland paediatric discharges

Portion of yearly discharges, by month
Percent



* December omitted as it contains a subset of patients admitted but not yet discharged

Source: HIPE 2003

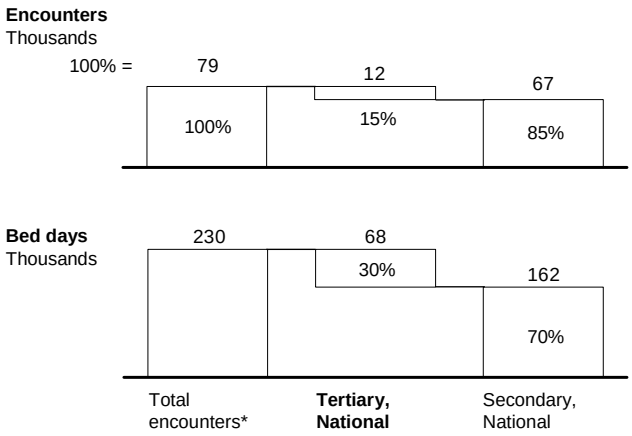
Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

Current national tertiary demand

Based on these criteria, we can estimate total bed demand in a few simple steps. We know that national tertiary demand to be 12,000 encounters (15% of total *inpatient* encounters), constituting 68,000 bed days.

TOTAL DEMAND FOR NATIONAL-TERTIARY CARE (1/2)

All inpatient encounters, age <16

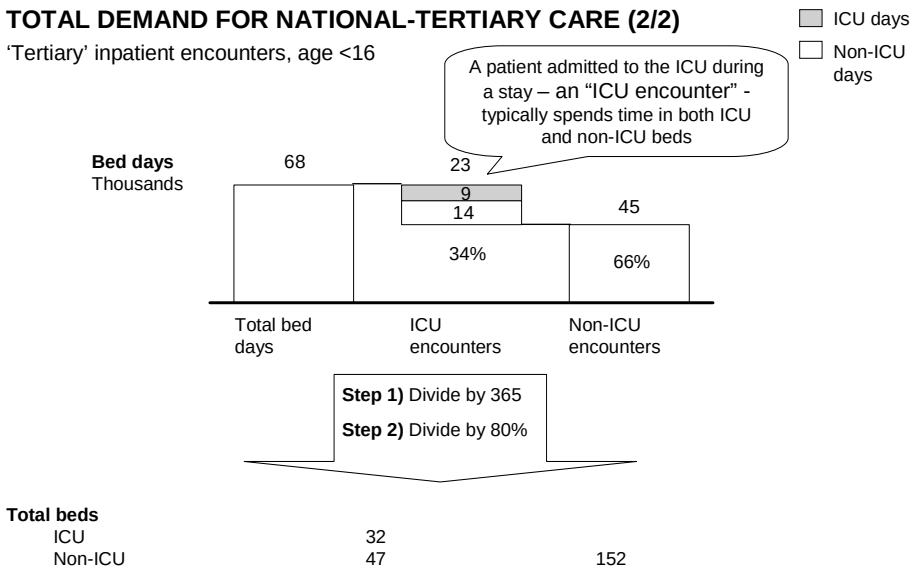


Source: HIPE 2003; team analysis

Once we know the estimate of bed days, we divide tertiary cases into ICU and non-ICU. Then, the totals are divided by 365 to change to 'beds', and divide by 80% target capacity. This gives the total demand:

- National tertiary care: 199 non-ICU, 32 ICU

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.



Source: HIPE 2003; team analysis

Scoping of Dublin secondary care needs and estimates methodology

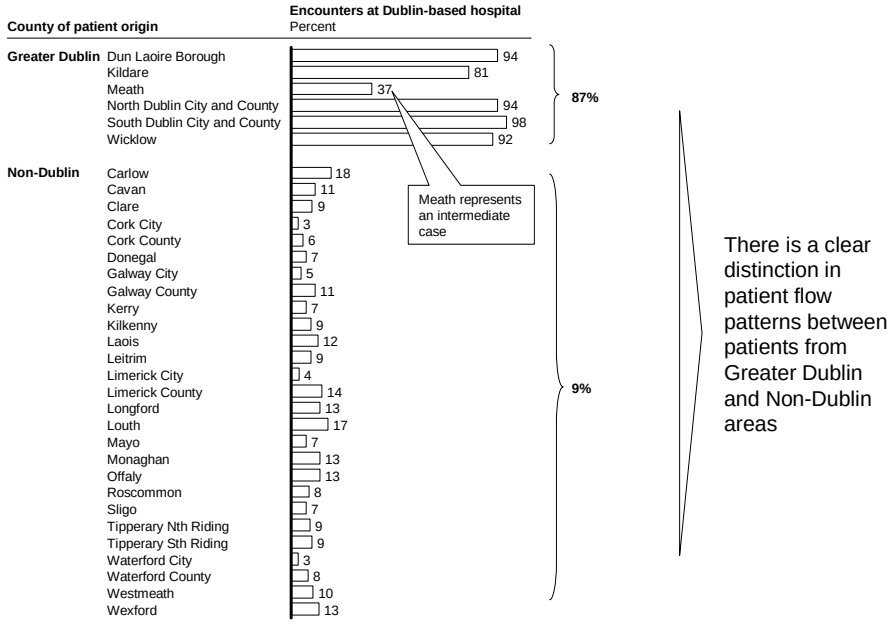
To understand where patients receiving Dublin-based secondary care were coming from, we needed to classify both hospitals and patients by location.

- **Classifying counties as part of Dublin secondary care catchments.** To see which counties' populations relied upon Dublin-based hospitals for secondary care services, we determined the proportion of all counties' total paediatric inpatient volume discharged from a Dublin-based hospital.

  Meath presented an intermediate case. Over 1/3 of Meath volume goes to a Dublin hospital, while the other 2/3rd goes primarily to Drogheda. It was decided to include Meath in the 'Greater Dublin' area based on three factors. First, the volume going to Dublin was still significantly higher than from other 'Non-Dublin' counties (where referral rates average 9%). Second, from a Dublin-hospital perspective, Meath children constitute a significant portion of total volume coming from the Mid-East counties. Third, future population growth in Meath is expected to be in the southern portion of the county, where patients are more likely to access Dublin for medical care. Of note, this volume represents only 3% of inpatient encounters nationally.

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

PROPORTION OF ALL DISCHARGES FROM DUBLIN-BASED HOSPITALS



Source: HIPE 2003, team analysis

With this information, counties were classified as being either part of 'Greater Dublin' (i.e. Dublin, Meath, Wicklow, and Kildare) or 'Non-Dublin'.

CURRENT UNDERSTANDING OF PAEDIATRIC PROVISION IN IRELAND

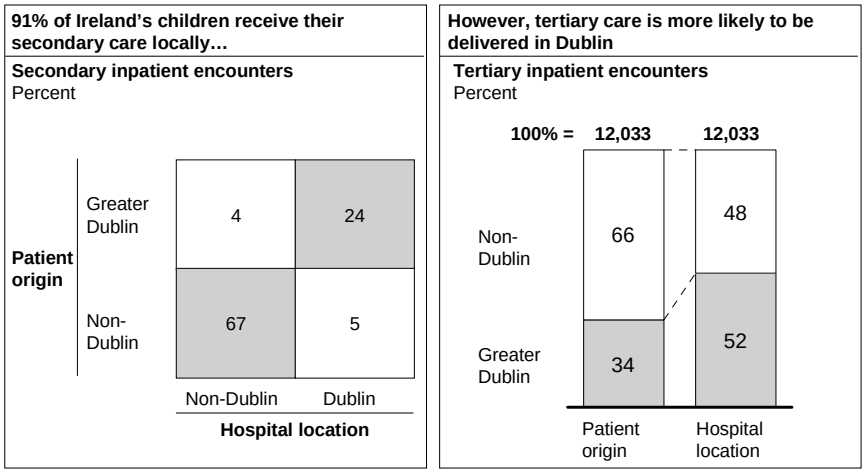
	Hospitals				
Classification	**Paediatric**	**Mixed**	**Primary Adult**	**Maternity**	**Speciality**
• "Greater Dublin"	• Crumlin • Temple St.	• Tallaght • Beaumont	• James Connolly • Loughlinstown • Mater • St. James's • St. Vincent's	• Coombe • Holles St. • Rotunda	• Cappagh • Royal Victoria Eye and Ear
• "Non-Dublin"			• All others	• All others	• All others

Source: Team analysis

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

With this geographic perspective, a number of findings on referral patterns become apparent. First, most 'secondary' encounters occur where the child lives: Non-Dublin patients receive care in Non-Dublin hospitals 91% of the time. Second, 'tertiary' encounters tend to be seen disproportionately in Dublin-based hospitals: Greater Dublin has 34% of the paediatric population, but 52% of the encounters.

LOCATION OF NATIONAL TERTIARY AND SECONDARY CARE DELIVERY
Inpatient encounters, age <16



Source: HIPE 2003; team analysis

Looking at 'Tertiary cases', we again see that 67% of total bed days occur at Dublin-based hospitals.

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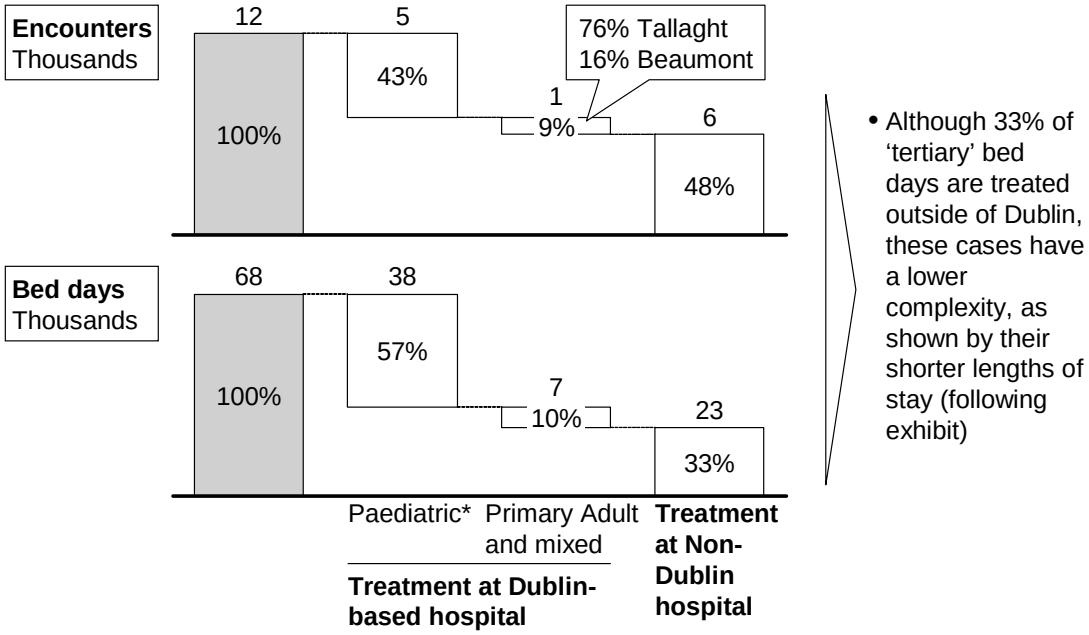
CURRENTLY, INPATIENT ENCOUNTERS CLASSIFIED AS 'TERTIARY' ARE PROVIDED AT A RANGE OF FACILITIES

Inpatient encounters, age <16



- Although 33% of 'tertiary' bed days are treated outside of Dublin, these cases have a lower complexity, as shown by their shorter lengths of stay (following exhibit)

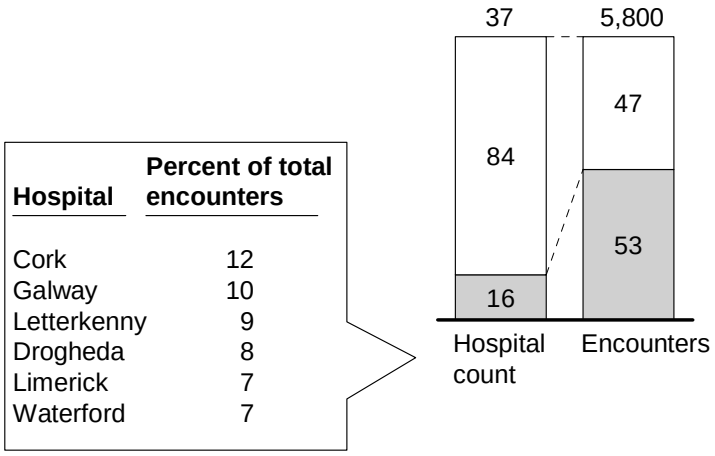
Source: HIPE 2003; team analysis

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

Of the ‘tertiary’ encounters treated at non-Dublin hospitals, most are treated at 6 facilities.

SIX HOSPITALS TREAT OVER HALF OF NON-DUBLIN ‘TERTIARY’ ENCOUNTERS EXHIBIT 26.3

Age <16



Hospital	Percent of total encounters
Cork	12
Galway	10
Letterkenny	9
Drogheda	8
Limerick	7
Waterford	7

Source: HIPE 2003; team analysis

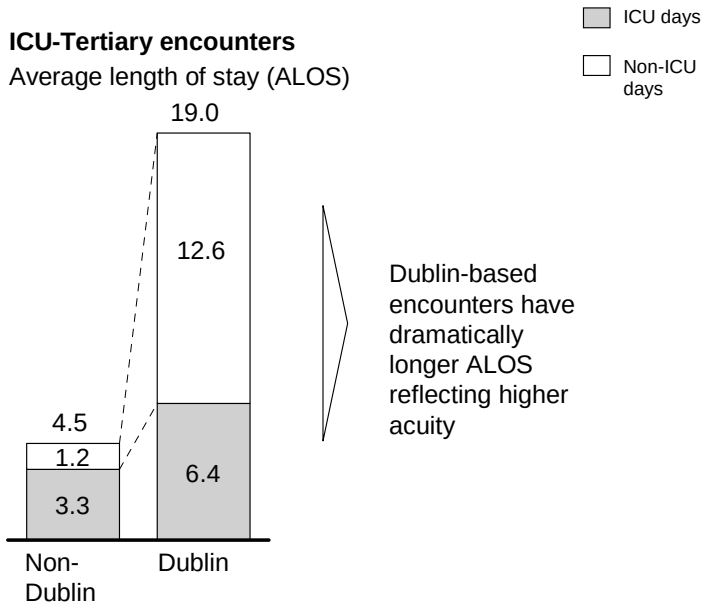
The presence of ‘tertiary’ encounters outside of Dublin is somewhat misleading. It does not reflect inappropriate care, but rather the limitations of a clinical classification schema that cannot account for on-the-ground clinical judgment. To confirm and illustrate this limitation, we have analysed the average length-of-stay (ALOS) by hospital location. The length of stay for a Dublin-based, ICU ‘tertiary’ encounter is 19.0 days, while for a non-Dublin based encounter it is 4.5 days: there is a clear difference in the complexity and acuity of two sets of ‘tertiary’ cases. There are two implications for the reader based on this data: first, the presence of ‘tertiary’ cases outside Dublin is an unavoidable artefact of a clinical approach, using DRGs, to classify discharges; second, the presence of a ‘tertiary’ designation does not and cannot be used to develop any perspective on the appropriateness of the place of treatment. What we can say is that the vastly different lengths-of-stay

Note: Designation of an encounter as ‘tertiary’, as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of ‘tertiary’ encounters from non-Dublin to Dublin centres is occurring.

demonstrate the clinical triage is occurring when physicians decide which tertiary cases to refer to Dublin.

LIMITATIONS OF 'TERTIARY' DEFINITION: ACUITY IS CLEARLY DIFFERENT BETWEEN DUBLIN AND NON-DUBLIN ENCOUNTERS

Age <16



Source: HIPE 2003; team analysis

For the remainder of the report, tertiary encounters referred from outside Dublin into a Dublin-based hospital will be referred to as 'referred-tertiary' encounters.

Current national tertiary and Dublin secondary needs

With a geographic classification schema, one can begin to understand what the secondary needs of Dublin are, in addition to the national tertiary needs:

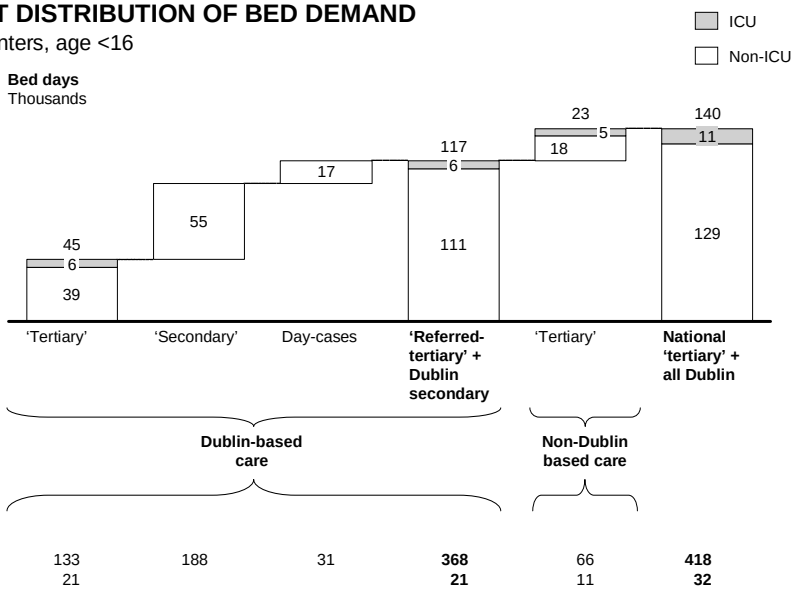
National tertiary needs:	199 non-ICU,	32 ICU
Dublin secondary needs:	188 non-ICU,	31 day-case beds

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

We know that national tertiary beds may be located within Dublin and non-Dublin based hospitals. This chart gives the reader a sense of how these national tertiary beds are distributed between Dublin and non-Dublin locations.

CURRENT DISTRIBUTION OF BED DEMAND

2003 encounters, age <16



Bed demand (count)	'Tertiary'	'Secondary'	Day-cases	'Referred-tertiary' + Dublin secondary	'Tertiary'	National 'tertiary' + all Dublin
• Non-ICU	133	188	31	**368**	66	**418**
• ICU	21			**21**	11	**32**

Note: Total excluded Neonatal at Dublin maternity hospitals and Non-Dublin neonatal admissions. Calculations target 80% capacity. Day-bed length-of-stay = 0.67

Source: HIPE; team analysis

PROJECTED DEMAND

The next task is to project future demand to 2020. Again, we will review the steps in our methodology for maximum transparency. First, we looked at the impact of projected trends and patterns of population change. This is a key sensitivity and one area where we have leveraged the most recent projections from the CSO. Secondly, we have looked at the impact of the longer term trends driving tertiary paediatric capacity. These include the impact of emerging clinical trends and technologic/clinical developments; trends in productivity/length-of-stay (LOS); and the availability and effectiveness of primary care outreach capabilities. Finally, we have estimated the impact of increasing patient complexity on bed mix. This analysis is inherently more subjective and we have applied a number of benchmark comparisons to provide an estimate of impact.

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

This approach generates the final projected requirements:

- National tertiary care: 161 non-ICU, 65 ICU beds
- Dublin secondary care: 189 non-ICU, 41 day-beds

The implications of these numbers on the configuration of care nationally and in Dublin are contained in Section 7.

The impact of population change

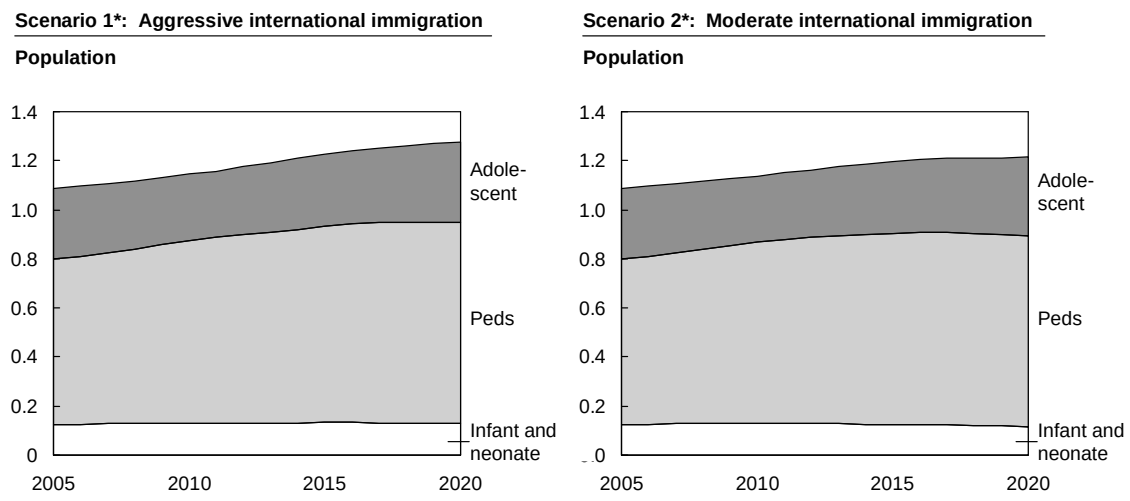
Three aspects of population growth will affect the nature and scale demand for beds: the overall population growth rate, shifts of population within the country, and international immigration. The latter are particularly important for demand estimates, as significant shifts to the greater Dublin catchments and high amounts of immigration are projected. All the findings presented here are based on the most recent Central Statistics Office (CSO) population projections (CSO: Regional Population Projections, 2006 – 2021; May 2005).

The CSO scenarios take account of several factors, including mortality and fertility rates, international immigration rates, and internal migration patterns. There are two international immigration scenarios publicly available (see appendix 5 for CSO methodology and detailed assumptions).

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

IRELAND POPULATION GROWTH PROJECTIONS

CSO Ireland, age <16



Note: Please see appendix for specific CSO methodology and assumptions

* Scenario 1 = M1F2 (high international immigration into country), Scenario 2 = M2F2 (moderate immigration). Both scenarios show above use 'Recent' internal immigration scenario to address internal migration to Dublin

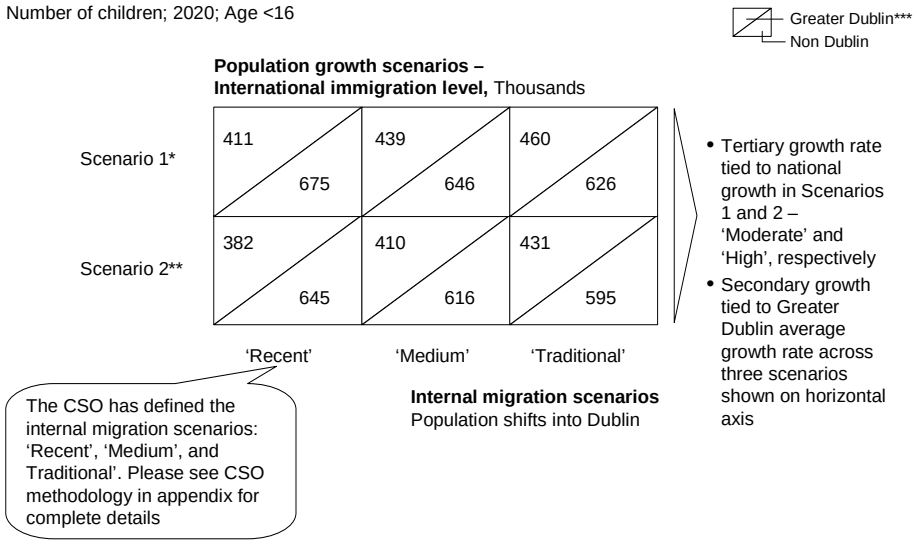
Source: CSO Ireland, team analysis

Additionally, there are three internal migration scenarios that model population shifts into Dublin: 'Recent', 'Medium', and Traditional. (see appendix for CSO methodology and detailed assumptions).

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

TOTAL PAEDIATRIC CASE GROWTH VARIES UNDER DIFFERENT POPULATION GROWTH SCENARIOS

Number of children; 2020; Age <16



Note: Please see appendix for specific CSO methodology and assumptions

* Scenario 1 = M1F2 (high international immigration into country), Scenario 2 = M2F2 (moderate immigration)

** Includes Mid East counties plus Dublin

Source: CSO Ireland, team analysis

For our base case, we have chosen the moderate international immigration case, 'Scenario 1'. Across all sensitivities, the 'Medium' internal migration scenario is taken. Additionally, the CSO divide projections into areas corresponding with Ireland's Regional Authorities. We have taken these projections and translated them to match our 'Greater Dublin' and 'Non-Dublin' classifications, and used these to generate our estimates for national tertiary demand and secondary demand for Dublin.

Projected national[GC2] tertiary and Dublin secondary demand incorporating population projections

- ¶ National tertiary care: 229 non-ICU, 37 ICU beds
- ¶ Dublin secondary care: 222 non-ICU, 41 day-beds

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

A comparison with the 2003 needs is presented below.

BED-DEMAND CHANGE: POPULATION GROWTH

		Dublin-based needs				Non-Dublin needs		
		'Tertiary'	'Secondary'	Day-case	Dublin Total	'Tertiary'	*National 'Tertiary'*	Notes
Current (2003)	Non-ICU	133	188	31	352	66	199	• Based on HIPE 2003 data • Day-case utilization assed at 1.5 cases/load/weekday
	ICU	21	–	–	21	11	32	
		Population growth						
2020	Non-ICU	153	222	41	416	76	229	• CSO Moderate international immigration 'Scenario 1', 'Medium' scenario for internal migration into Dublin.
	ICU	24	–	–	24	13	37	

Further factors impacting projected national tertiary and Dublin secondary demand

Looking forward, our broad experience suggests several factors beyond population growth will affect total bed needs. Specifically, we would highlight innovations in service configuration - such as specialist outreach programs, enhanced primary and community care, and enhanced productivity (as exemplified by decreasing length-of-stay internationally and the general shift to day cases) - are all likely to reduce total bed demand. Other factors, such as technological advances in treatment and greater ethnic diversity in the population, are likely to affect the mix of specific sub-specialties within the inpatient population.

We have examined the potential impact of each of these factors. Note that since any estimation of bed demand has to take account of these multiple factors, a significant amount of judgement will be required in ultimately planning the system.

- **Outreach Programs and Primary Care reform**: Lack of access to outpatient specialist care leads to avoidable exacerbation of chronic diseases and thus to avoidable discharges. Similarly, not being able to get

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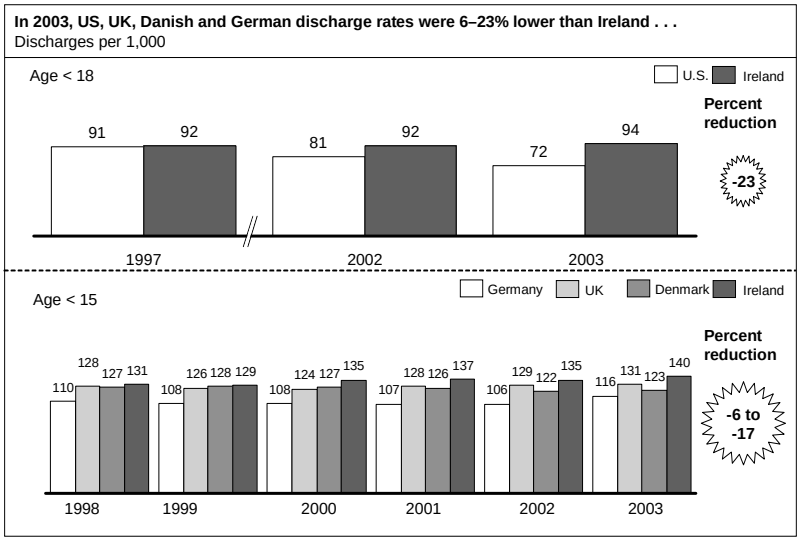
timely access to a GP leads to more ‘secondary’ discharges for common ailments.

¶ **Decreasing LOS through enhanced efficiency**: As healthcare reforms impact national systems, typically the average inpatient LOS is driven down. However, having fewer ‘simple’ discharges in tertiary centres,

¶ due to the impact of programmes such as the outreach program noted above, leads to a higher case-mix index for the remaining inpatients – which tends to drive the average LOS back up.

Comparison[GC3] with international benchmarks suggests that the rates of paediatric discharges can be steadily reduced with more outreach and stronger primary care. Benchmarking against other countries with data readily available (i.e. the US, Denmark, the UK, and Germany), we see that by reducing Ireland’s hospital paediatric admission rate, while keeping length of stay (LOS) in check, one could potentially reduce inpatient utilisation from 6-23%. We have chosen the mean international performance level as a target as a basis for planning; reducing this performance level implies a decreased utilisation of 15% for Ireland by 2020.

IMPROVEMENTS IN PRIMARY CARE AND OUTREACH PROGRAMMES MAY REDUCE BED DEMAND TO MEAN INTERNATIONAL LEVELS – A 15% DECREASE



Source: CSO; HIPE; CMMS (U.S.); Diagnosis Statistics and Census (Germany)

Note: Designation of an encounter as ‘tertiary’, as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of ‘tertiary’ encounters from non-Dublin to Dublin centres is occurring.

¶ **Clinical mix-shift: Medical and technological advances, and changing ethnicity**: Clinical advances and ethnic mix-shifts tend to affect specific services. While the breadth of clinical advances may ultimately impact multiple specialties, we have focused on high-volume services where changes will have a meaningful impact on the inpatient clinical mix. To understand what that impact might be, we have developed a perspective, based on expert interviews, on the likely effects of the key advances in the highest volume secondary and tertiary lines. Similar to medical advances, increasing ethnic diversity affects niche clinical services (e.g. increasing African population will increase the prevalence of sickle cell anaemia), and is also addressed below.

MEDICAL ADVANCES IMPACT ON KEY DUBLIN-BASED SECONDARY SERVICES

Secondary encounters; services >5% total bed-days for Greater Dublin

Service line	Percent of total bed-days	Trend in volume	Rationale
Pulmonary Medicine	17	↔	• Majority of encounters are for pneumonia, bronchitis, and asthma. Incidence of asthma may increase modestly.
Gastrointestinal Medicine	15	↓	• Advent of GI-related viral vaccines will decrease the incidence of viral gastroenteritis and subsequent supportive admissions
ENT Surgery	8	↔	• Cochlear implants will generate more discharge volume, but primary drivers remain common interventions such as T&As and myringotomies.
ENT Medicine	7	↔	• Otitis media and URI will continue to generate majority of encounters, with no change in incidence anticipated
Neurological Medicine	7	↔	• Seizure incidence not anticipated to change, but progress in neurosurgical interventions for seizure disorder will increase volume in neurosurgery.
Infectious Diseases	6	↔	• Largest volume driver is non-specific viral illness • Potential for idiosyncratic spikes in volume with increased immigration, SARS, avian flu, etc.
Urology Medicine	6	↔	• Urinary tract infections secondary to both congenital and non-congenital aetiologies drive volume, incidence is not anticipated to change.
Total	**65%**		

Source: Interviews; HIPE; team analysis

Summary: For high-volume secondary–care service lines, little change is anticipated in long standing, common ailments. One notable exception is likely a decrease in supportive admission for episode of viral gastroenteritis.

Note: Designation of an encounter as ‘tertiary’, as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of ‘tertiary’ encounters from non-Dublin to Dublin centres is occurring.

MEDICAL ADVANCES IMPACT ON KEY NATIONAL TERTIARY SERVICES

Tertiary encounters; services >5% total bed-days for Ireland

Service line	Percent of total bed-days	Trend in volume	Rationale
General Surgery	19	↔	• Most inpatient days are driven by patients with tracheostomies. Complicated appendectomies unlikely to change in prevalence.
Haematology	8	↑	• Blood cell dyscrasias will increase with continued immigration
Oncology Medicine	8	↔	• Leukaemia and chemotherapy related encounters are volume drivers. Although better treatments and survival lead to increased recurrence, downstream admissions tend to occur after age of 18.
Pulmonary Medicine	6	↔	• Respiratory illnesses with a comorbid condition. Incidence of cystic fibrosis not predicted to change; benefits of decreased mortality already extend into adulthood.
Neurological Medicine	6	↔	• Bacterial meningitis primary driver; incidence unlikely to change without change in vaccination utilisation.
Cardiovascular medicine	6	↔	• Nonsurgical encounters for congenital heart disease. Primary driver is incidence of congenital disease, which is stable,
Heart surgery	6	↔	• Surgical interventions for congenital anomalies.* Primary volume driver is still prevalence of congenital defects.
Neonatal	5	↔	• Necrotising enterocolitis and meconium obstruction are typical diagnoses. Prevalence not anticipated to change.
Total	**62%**		

* E.g. great vessel transposition

Source: Interviews; HIPE; team analysis

Summary: Increasing ethnic diversity will increase the number of encounters for sickle cell and thalassemia-related encounters. Sickle cell will tend to increase the rate of outpatient MRI utilisation.

¶ ***Day-cases***: another source of efficiency is the increasing movement towards performing procedures and diagnostics in a day-case setting rather than the inpatient setting (a phenomenon which has quality and convenience benefits, in addition to an economic rationale). To determine the maximum impact that the trend towards day cases could have on sizing, we converted all 1-day and 2-day elective inpatient encounters in Ireland to day-cases. In this instance, we modelled an assumption on the basis of current Irish data since direct comparable international data was not available. We focus on 1-2 day elective discharges – those that did not pass through the A&E channel – as these can reasonably be assumed to be candidates for day-case. (While recognising this rationale likely overestimates the number of cases that could be converted to day-cases.) We also based our assumption on the current average usage rate of 1.5

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cases/day-bed/weekday (a factor which may understate the future potential given improving productivity).

Analysis indicates that even under optimistic assumptions, converting inpatient encounters to day-cases would at only reduce the total bed requirement 2.1%. We have therefore not included this as a major driver of change in future demand.

CONVERSION OF INPATIENTS TO DAY-CASES YIELDS LITTLE REDUCTION IN TOTAL BED REQUIREMENTS

Based on 2005 utilisation data, up to 1.5 day-cases can be performed per bed

	Day-beds	Cases	Calculated cases/ room*
Crumlin	31	11,400	1.5
Temple	18	4,800	1.1

Elective, 1 and 2-day inpatient encounters are likely candidates for conversion to day care

Length of stay	Elective encounters Count	Portion of inpatient bed-days Percent	Total bed reduction from conversion To day case Percent
One-day	6,100	2.7	0.8
Two-day	4,000	3.5	1.3
Both		6.2	**2.1**

While we have generally not utilised Ireland based operational data, doing so was necessary to this analytic approach

- Upper boundary on total bed reduction from conversion of inpatient to day-cases (using 1.5 cases per-bed per-day as benchmark)
- Shift to day-cases *does*:
  - **Increase quality** by avoiding admissions
  - **Increase** patient **convenience**
  - **Decrease labour costs** due to lower staffing hours

* Assumes room utilised 251-day year, i.e., weekdays excluding national holidays

Source: HIPE; team analysis

¶ ***Changes***[GC4] ***in bed-mix due to greater complexity.*** A higher case-mix index means the complexity of the remaining inpatient cases also increases. As one expert put it, "What was once tertiary becomes secondary, and where once your patients didn't survive - they become your quaternary cases." Additionally, upgraded clinical capabilities (e.g. performing living-related liver transplants, more complex interventional radiology procedures, etc) will increase complexity of care. This will increase demand for ICU beds.

Based on the projections thus far, ICU beds constitute only 6% of Dublin-based inpatient beds by 2020. Looking internationally (excluding NICU beds), we see that in the US, about 19% of total beds are PICU or HDU (one expert predicted that this

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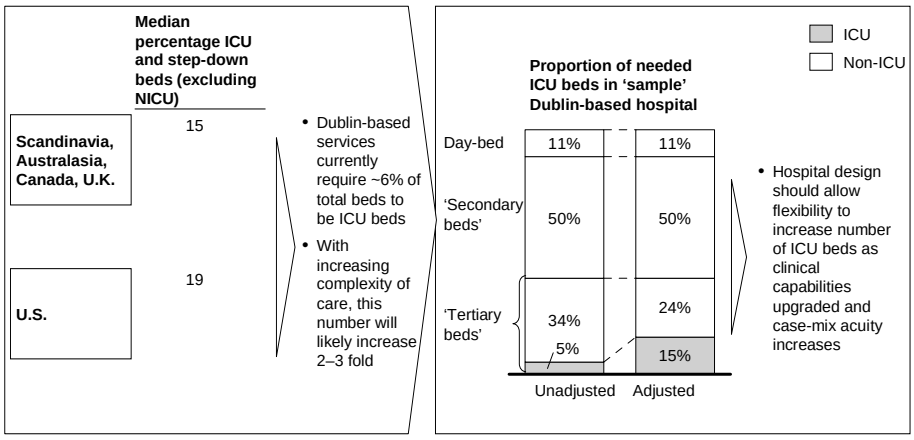
number would climb to 25- 30% of all beds in new builds). In other countries, where the move towards specialist care and LOS reduction has been less pronounced, ICU and HDU beds constitute about 15% of total beds.

We expect that by 2020, Dublin-based ICU beds will proportionally reach current US levels, representing a 3-fold increase. While this proportion of ICU beds may not be necessary in 5 years, plans for the medical centre should include the option of converting non-ICU to ICU beds, or construction of new ICU beds.

UPGRADING CLINICAL CAPABILITIES AND DECREASING 'SIMPLE' ADMISSIONS INCREASES ICU BEDS NEEDED



Source: Interviews; team analysis, HIPE 2003

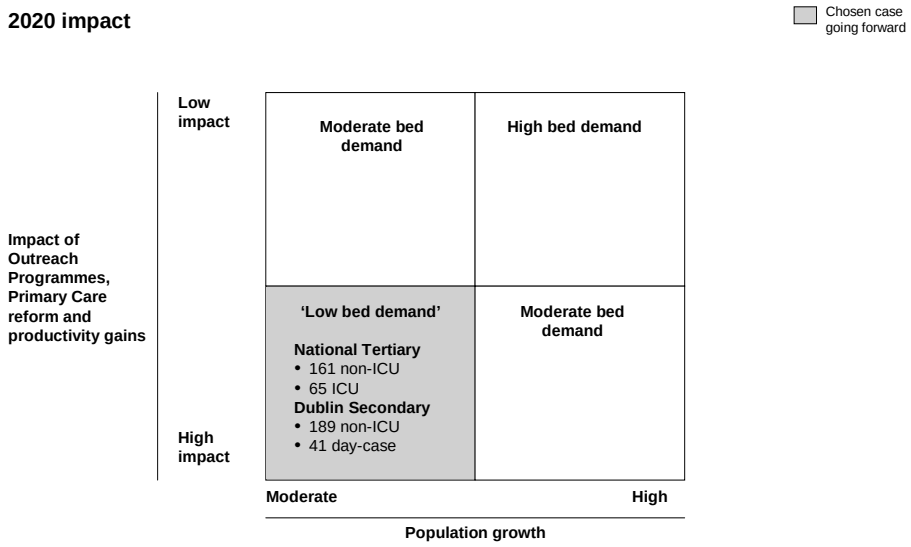
Projected national tertiary and Dublin secondary demand incorporating population and key trends

From the above analysis, we have prepared a base case for demand in 2020, and lay out some sensitivities. The base case is modelled on the moderate population projections and assumes closing the gap to international best practice to reach average practice. ICU beds are set at 15% of total tertiary beds, the current European average.

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

CONSOLIDATION OF TRENDS WITH POPULATION GROWTH SCENARIOS

2020 impact



Source: CSO; HIPE 2003; team analysis

¶ This set of scenarios would imply bed needs of:

- National tertiary care: 161 non-ICU, 65 ICU beds
- Dublin secondary care: 189 non-ICU, 41 day-beds

Recall that in this sense, 'national tertiary' refers to all tertiary cases, whether treated in Dublin-based hospitals or non-Dublin based hospital

¶ From a Dublin perspective, this would generate the following distribution of bed demand, relative to 2003-based projections:

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

BED-DEMAND CHANGE: SCENARIO IMPACT

		Dublin-based needs				Non-Dublin needs		
		'Tertiary'	'Secondary'	Day-case	Dublin Total	'Tertiary'	*National 'Tertiary'*	Notes
Current (2003)	Non-ICU	133	188	31	352	66	199	• Based on HIPE 2003 data • Day case utilization assed at 1.5 cases/load/weekday
	ICU	21	–	–	21	11	32	
		Population growth						
2020	Non-ICU	153	222	41	416	76	229	• CSO Moderate growth 'scenario 1'
	ICU	24	–	–	24	13	37	
		Scenarios						
	Non-ICU	96	189	41	326	65	161	• High impact of primary care and specialist outreach initiatives yields 15% reduction in inpatient encounters • Inpatient shift to day-cases has minimal impact • ICU proportion of beds increased 3-fold to 15%, total 'tertiary' need remains stable
	ICU	54			54	11	65	

Source: HIPE, team analysis

¶ **Impact of key sensitivities**: We have modelled based on the scenarios showing that population growth will be only moderate, and the access and outreach programs will be effective. This approach makes sense from a planning perspective: assuming options are preserved, decisions regarding construction of additional units can made later, when information is on hand. To give some perspective to the low-case scenario, we have modelled the converse set of assumptions: population growth is high, and the impact of reforms is low. This generates the highest number of beds:

- National tertiary care: 215 non-ICU, 81 ICU beds
- Dublin secondary care: 248 non-ICU, 41 day-beds

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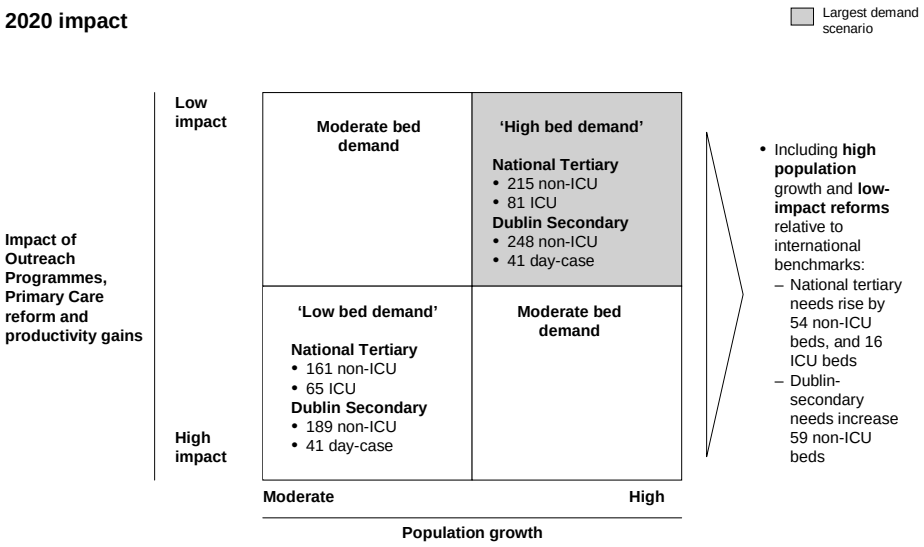

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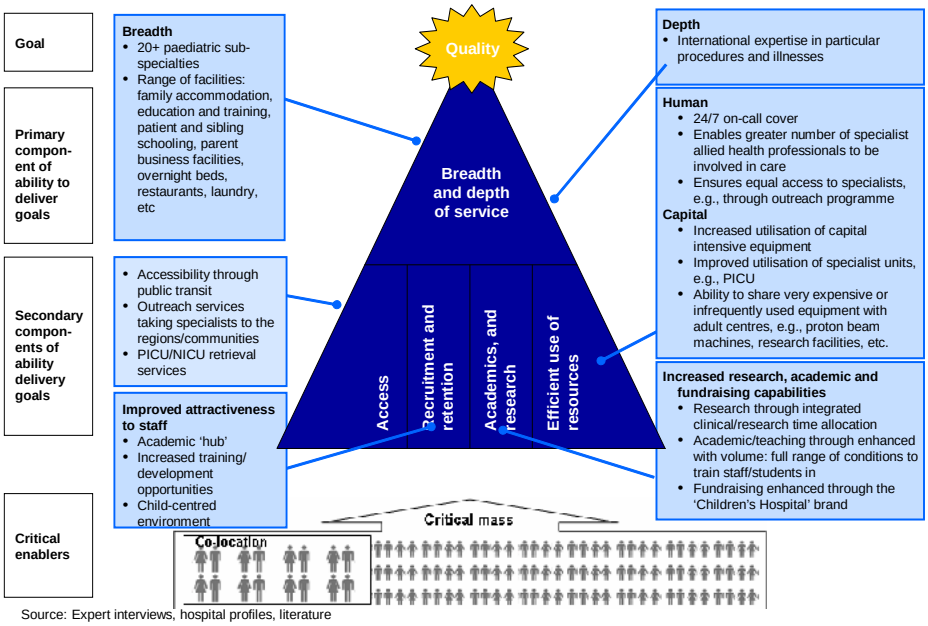
6. Configuration of tertiary paediatric services for Ireland and secondary services for Dublin

International best practice provides the following "blueprint" for the provision of tertiary paediatric care nationally and secondary provision in Dublin. We reiterate what is clear from international best practice and note those areas which will require local tailoring to Irish needs.

The following will be key elements in delivering the desired quality of care. The cornerstones are an integrated tertiary service system with a <u>single</u> tertiary centre of sufficient critical mass to offer the required breadth of services

- ¶ Population and projected demands of Ireland can support only one world class tertiary centre
- ¶ This centre would have the following attributes:

DETAILED COMPONENTS OF REQUIREMENTS TO DELIVER BEST PRACTICE IN TERTIARY PAEDIATRIC SERVICES



Source: Expert interviews, hospital profiles, literature

- ¶ This centre would be in <u>Dublin</u>

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- It would ideally be co-located with a leading adult academic hospital (to capture the sub specialist and academic linkages discussed earlier)
- It would have with space for future expansion (including education and research facilities)
- It would be easily accessible through public transport and the road network.
- (…with all these considerations subject to the suitability and flexibility of available sites)

¶ The centre would be at the nexus of a integrated paediatric service, also comprising:

- Important outreach capabilities at key Non-Dublin hospitals
- Adequate geographic spread of A&E facilities (including 2-3 in Dublin). Treatment at 'urgent care' centres is another option. These centres are either stand alone or attached to an adult facility with no inpatient children's beds. They should be staffed by general paediatricians. When children need to be admitted, they are transferred to the tertiary centre. The need for transferring is manageable because 85-90% of paediatric visits are discharged to home, and ambulances are instructed to take all acute volume directly to the tertiary centre.

¶ Our 'pure' and clear view based on a broad base of advice is that this centre would also provide care for all the secondary needs of Greater Dublin (subject to the obvious and significant step of translating this into a workable plan – which we have not looked at). Across the world we have seen all spectrum of secondary and emergency care provision. Tertiary centres, with a few notable exceptions, e.g., Great Ormond Street, all take secondary patients. One important reason is their need for volume to maintain skills; another is the uncertain boundary between tertiary and secondary; last but not least is their need to be part of their local community, for example, by keeping the A&E doors open to the local population.

¶ International centres have a broad range of theatres and diagnostic equipment, the number of which are determined by inpatient case-mix and service line niches. For outpatients, all tertiary centres provide

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comprehensive outpatient imaging and laboratory services. Provision of space for specialist consultant outpatient clinics is variable.

EQUIPMENT AND BEDS

	Avg. beds	Ratio beds to			ICU beds as % of total beds, percent			
	Count (range)	MRI	CT	Operating theatres	PICU	NICU	HDU	Total
Australasia, Canada, Scandinavia, U.K.	241 (195–263)	163* (118–254)	231* (120–314)	38* (24–49)	7 (5–10)	13 (11–16)	5 (3–7)	18 (15–22)
U.S.	344 (180–514)	87 (82–90)	95 (60–136)	23 (15–33)	13 (6–18)	22 (11–33)	8 (4–11)	40 (21–58)

* Many of these hospitals share facilities with adult services – these figures represent the child-dedicated service only
Note: PET scanner present in Texas, Cincinnati centres, HSC (Toronto) as reported by hospitals themselves

Bed demand for Dublin-based tertiary centre

From a Dublin-perspective, the 'referred' and 'local' tertiary care, combined with Dublin's secondary care needs, generate the following bed demand.

- ¶ Dublin 'Referred' and 'Local' tertiary needs: 96 non-ICU, 54 ICU
- ¶ Dublin secondary needs: 189 non-ICU, 41 day-beds
- ¶ **Dublin Tertiary Centre**:
  - **Total: 380 beds**
  - **Bed-mix: 285 non-ICU, 54 ICU, 41 day-bed**

Note: Designation of an encounter as 'tertiary', as identified by our clinical classification schema, is not intended or able to assess the appropriateness of the location of treatment. Dublin versus non-Dublin ICU-flagged encounters have lengths-of-stay of 19.0 vs 4.5 days, suggesting that, in aggregate, triage of 'tertiary' encounters from non-Dublin to Dublin centres is occurring.

7. Decision criteria and next steps

The recommended ‘blueprint’ is informed by: (1) international best practices in the provision of tertiary paediatric services; and (2) the likely shape and nature of demand for national tertiary and Dublin secondary paediatric services.

In this context, we believe the evidence for one national tertiary paediatric centre based in Dublin is compelling. All the experts drawn upon emphasised the value of concentration of sub specialist services and clear need for this centre to be co-located with an adult academic hospital.

The next step is to ensure this is translated into compelling practical plans for Ireland. It is beyond the scope of this report to propose on how current plans and proposals should be assessed, however we would propose the following criteria:

PROPOSED ASSESSMENT CRITERIA

1. Space	• Ability to meet projected tertiary and secondary needs (including potential to accommodate research and education facilities)
2. Breadth and depth of services	• Centre should offer the following services: – Sub-specialist capability across the 25+ core sub-specialties: Medical - Anaesthetics, Cardiology, Endocrinology, General Medicine, Genetics, Haematology, Immunology, Infectious Diseases, Intensive care, Neonatology, Nephrology, Neurology, Oncology, Opthamology, Pathology, Radiology, Respiratory +/- allergology, Rheumatology, Microbiology and clinical chemistry; Surgical - Cardiothoracic surgery, ENT surgery, Gastroenterology/GI/ hepatobiliary surgery, General surgery, Neurosurgery, Orthopaedic surgery, Transplant surgery, Urology – A patient and family focused environment and services; including accommodation and schooling learning from recent best practice trends (e.g. parent and child rooms % single rooms)
3. Co-location	• The preferred option would be co-location. If so, needs to be specific about level of integration and sharing of services. If not co-located, need to be specific about how to address the challenges of isolation from adult services
4. Access	• Comprehensive outreach programme with other hospitals providing in-patient paediatric services in critical sub-specialties • National retrieval plan and ambulance diversion protocol for Dublin • Clear referral protocol and supporting liaison with Dublin A&E centres • Provision for “hospital hotel” facilities and family accommodation on site • Good public transport and road links
5. Efficient use of resources	• Parking for families and staff • Sufficient activity levels to support 24/7 cover in key sub-specialities and other multi-disciplinary support services
6. People - attract and retain	• Appropriate sharing of diagnostic equipment and other operational services • Attractive work environment and interesting career opportunities
7. Teaching and research	• Clear Children’s Hospital ‘brand’ • Strong integration with under graduate and post graduate training programme, especially in medicine and nursing • Mandate to pursue clearly defined research agenda as part of child care mission, building upon the best of what is already ongoing and ensuring alignment with Ireland’s long term research and innovation goals
8. Financial stability	• Brand and associated governance status to enable fundraising for research • Sufficient budget to manage complete services and range of sub-specialties within hospitals including necessary outreach and retrieval programme and additional sub-specialists as appropriate
9. Full project plan and role assessments	• Budget to reflect likely trend to higher case mix index • Credibility of proposal including ability to execute capital project and willingness to address roles, in particular with respect to cooperation with other providers (e.g. A&E) and to support integration with adult services where there are clear benefits

Beyond the above assessment criteria, further work will be required to define the mission and role of each of the non-Dublin hospitals as part of one integrated national paediatric service.

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