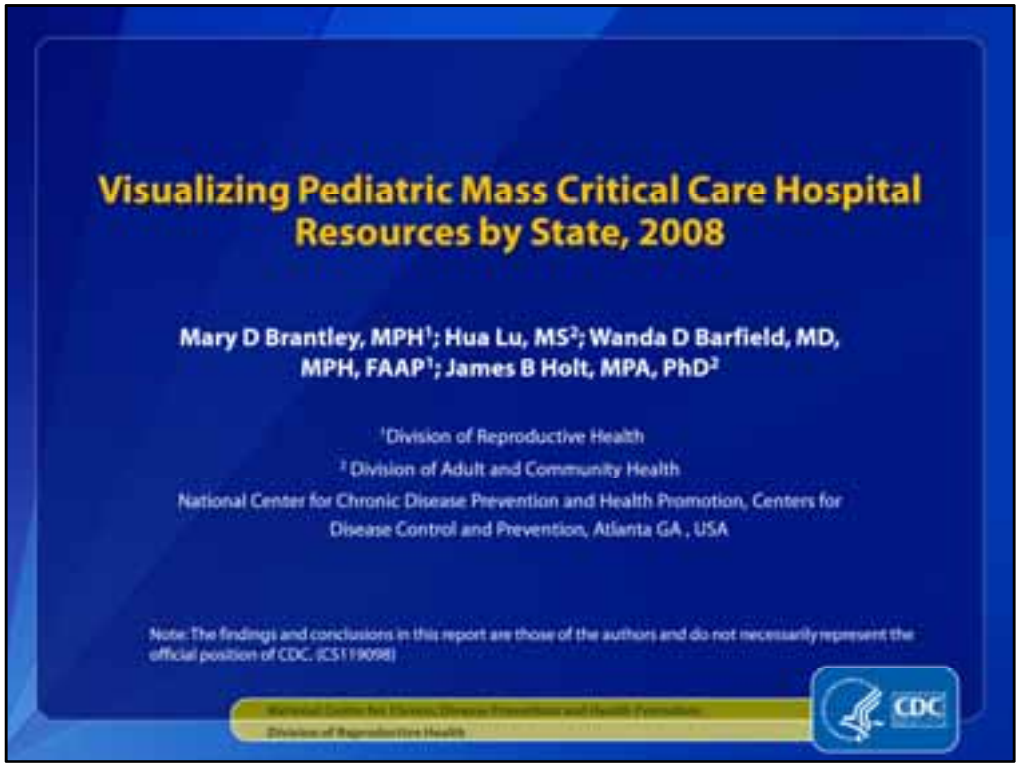


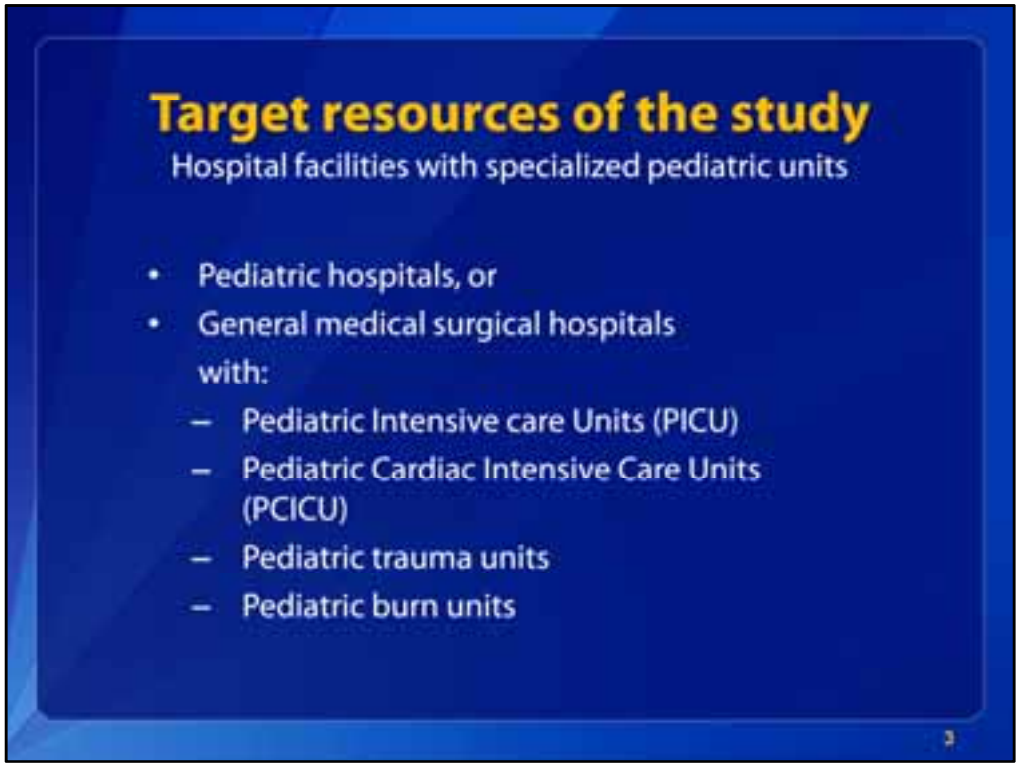
Planning for pediatric mass critical care must be based on a foundation of information about existing resources so that they can be organized effectively in a public health emergency. Unfortunately, national information about existing pediatric emergency and critical care resources is limited.

This presentation is the first of several geospatial analyses used to describe the current state of pediatric critical care resources and to plan for future regionalization of these resources. It provides a visual and analytic overview of existing hospital resources, and will serve as the basis for the regionalization of these resources.

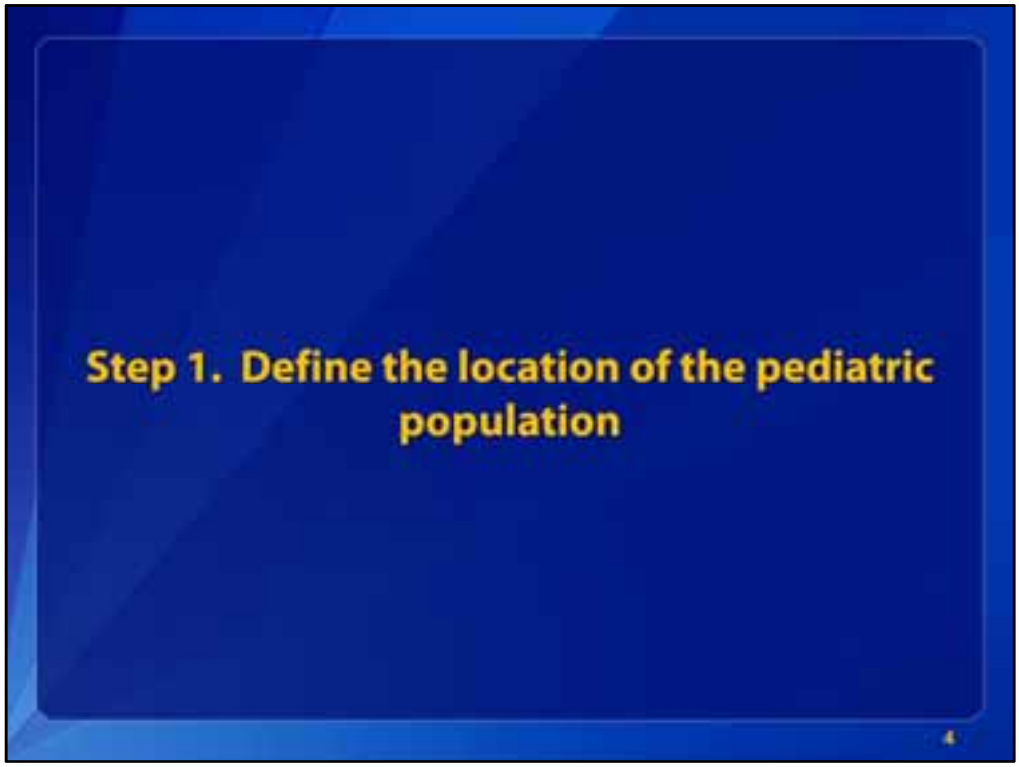
Children are not miniature adults. They have unique physical and emotional needs, and when ill or injured, require specialized care and equipment.

But despite the evidence that specialized pediatric services are beneficia[1-5], gaps in service locations[6,7] still exist and often interfere with use of existing pediatric critical care resources.

And pediatric needs in a large public health emergency would certainly exceed the resources of individual facilities and could only be served by distributing available resources across a region.



The purpose of this analysis is to describe the extent to which the pediatric population has access (as defined by proximity) to pediatric and other specialized facilities within the continental US, and to highlight regional differences in population and resource distribution which are critical to preparedness planning and appropriate utilization during a mass public health disaster[8].



We did this by creating a dasymetric map of the pediatric population. Dasymetric mapping methods were used to distribute 2008 county level US Census population estimates for children age 0 to 17 years to a 30 x 30 meter grid for the entire US.

This presentation highlights the use of dasymetric mapping as a tool for public health preparedness planning. Dasymetric mapping for population density is preferable over other methods because of its ability to realistically place data over geography. Although the field of public health still relies heavily on choropleth (thematic) maps, dasymetric maps are becoming more prevalent in the developing fields such as preparedness and sustainable development. It is an example of the use of so-called critical GIS.

Data sources for the dasymetric map

- Pediatric population:

  US Census Bureau American Fact Finder download center

  http://factfinder.census.gov/servlet/DCGeoSelectServlet?ds_name=PEP_2008_EST&_ts=295190314730

- Land cover (geographic) layer:

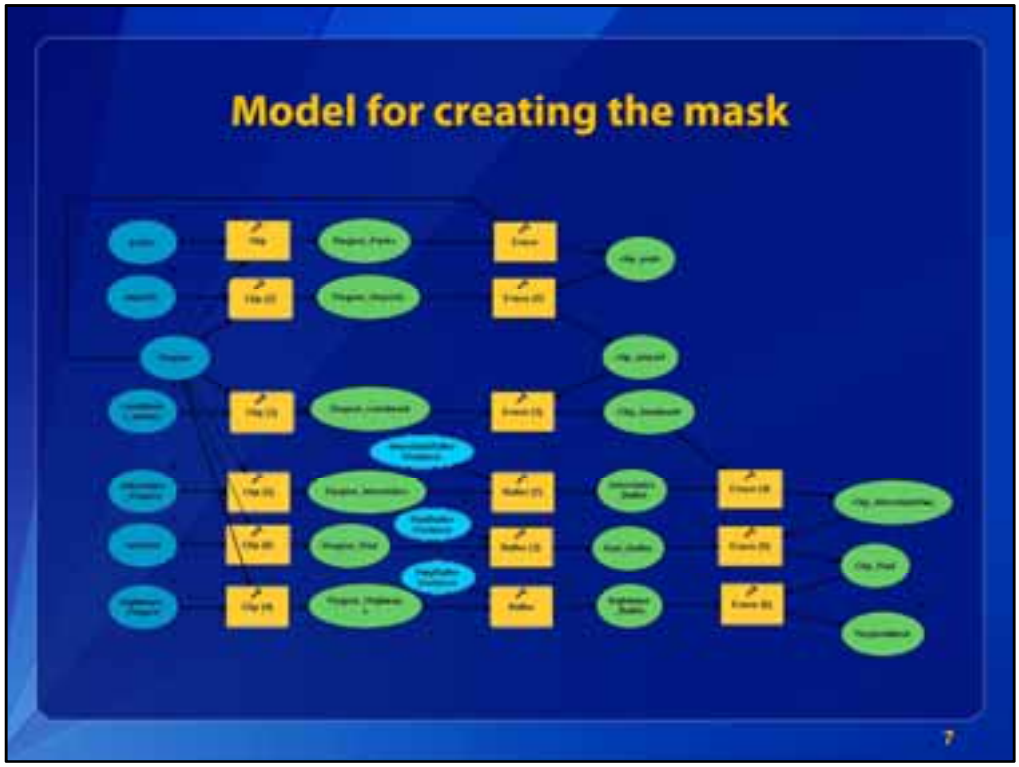
  US Geological Survey

  http://www.mrlc.gov/nlcd_multizone_map.php

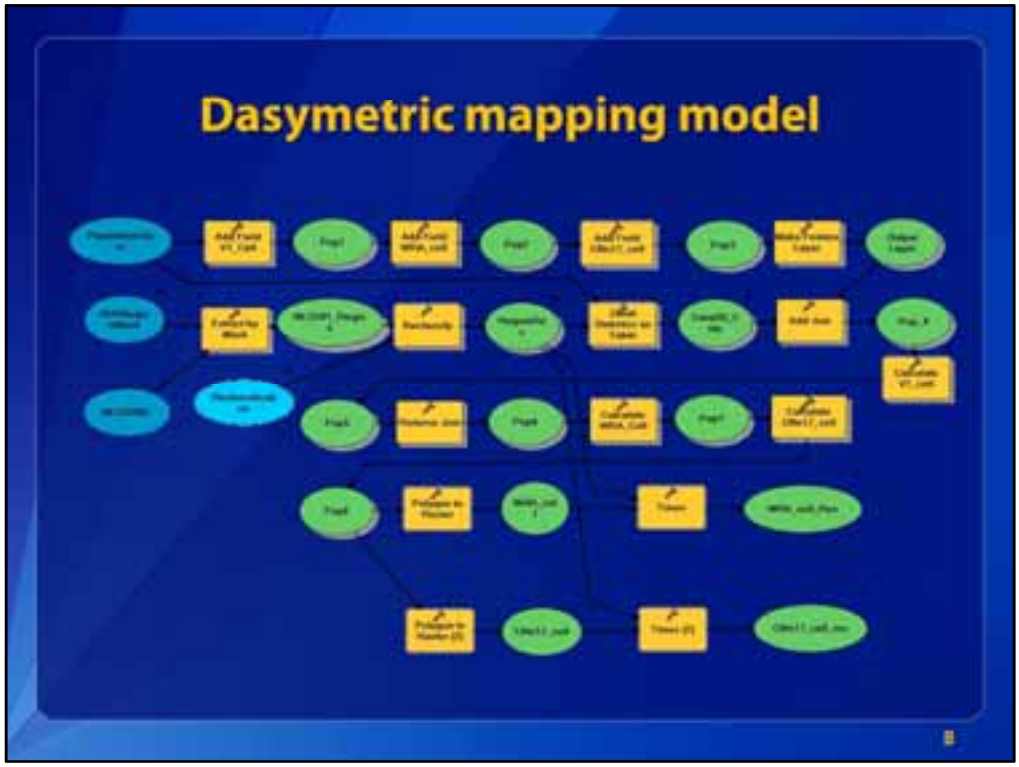
5

The distribution was based on urban imperviousness as defined by the National Land Cover Data (NLCD2001). Note: Urban imperviousness is not the same as urbanized areas. It merely reflects the presence of a build environment wherever that may be.

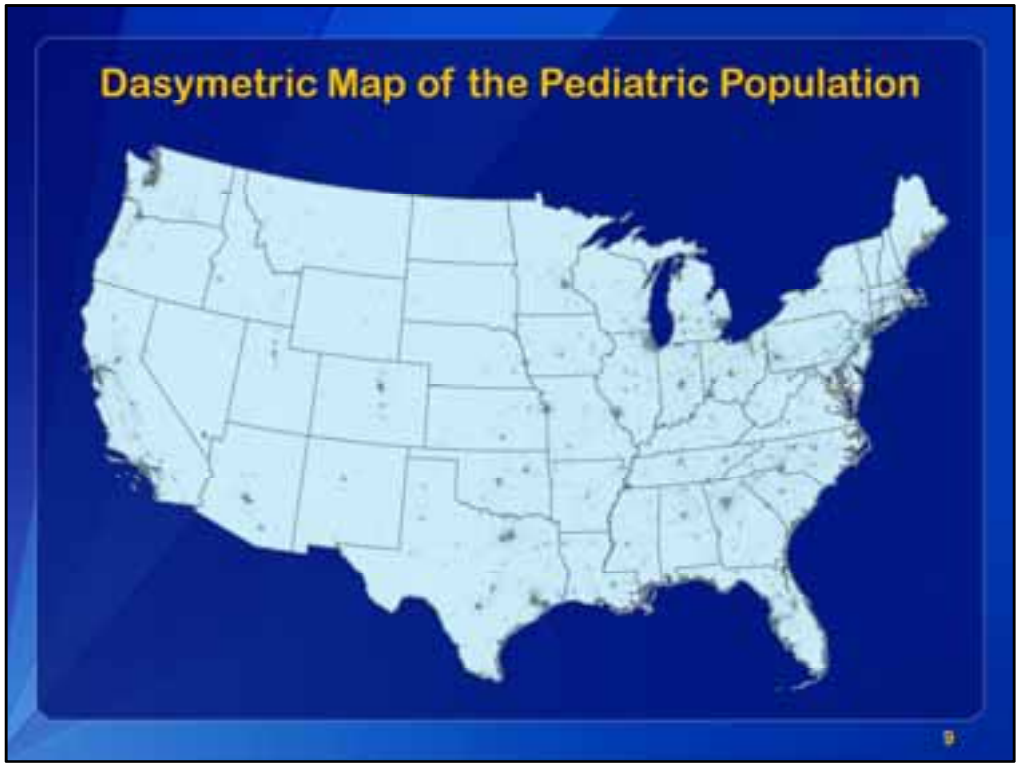
A residential area layer was defined using the urban imperviousness classification on the NLCD to identify urbanized areas; these areas were reclassified into 1,0. (1 = residential area, 0 = non-residential area).



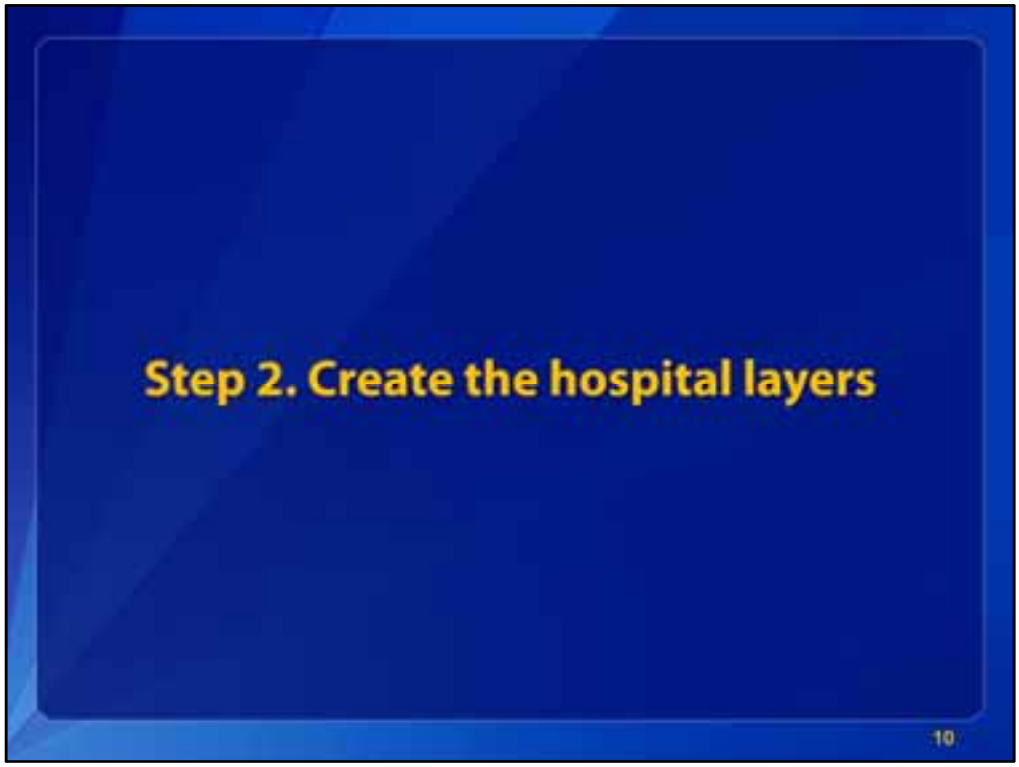
Highly urbanized areas, areas that would not be considered residential, were removed by creating a mask of known landmarks such as airports, parks, and other large highly urbanized or industrial areas as well as interstates, highways, waterways, roads and railroads; and then using mask in an ArcGIS Model Builder model to erase these areas from the land cover data.



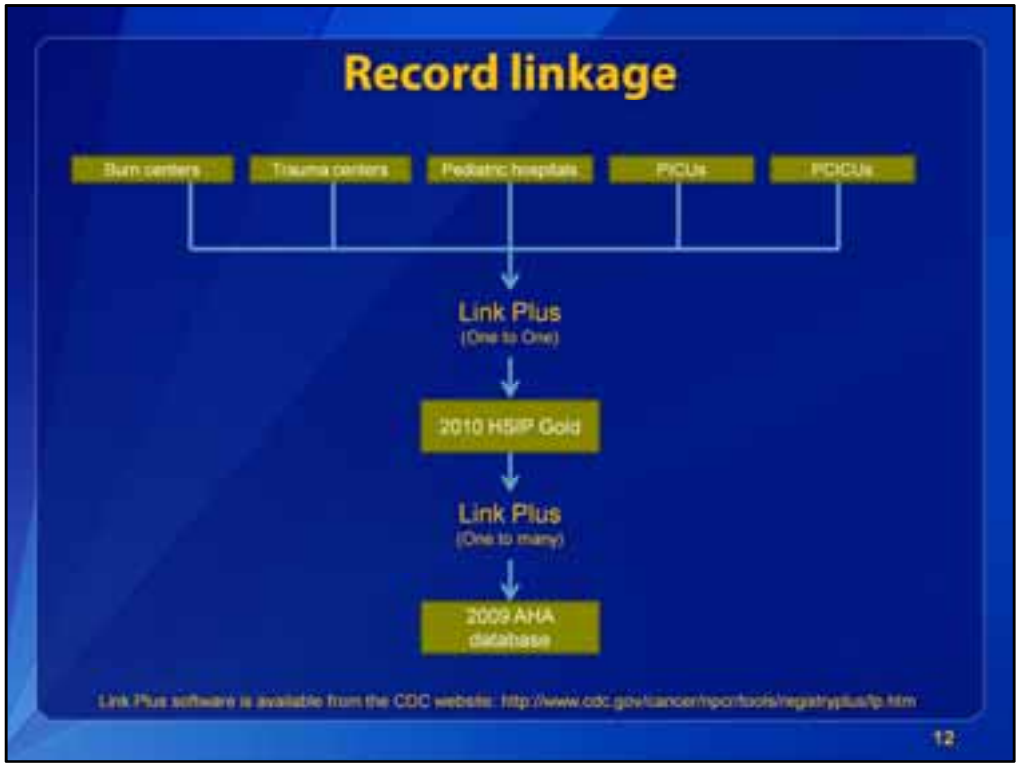
Dasymetric mapping of large areas is labor intensive and consumes large amounts of computer resources; therefore the process was broken down by regions of the country and processed using a second ArcGIS Model Builder model to ease the stress on the computer system and ensure reproducible results across the country. Each region took about 8 hours to run. The regions were then mosaic'd together to form a single national grid layer of the pediatric population.



Finished product.


Step 2. Create the hospital layers
10

Lists of pediatric and other specialty hospitals and centers in the US were acquired from their respective national and international accrediting agencies such the American College of Surgeons for trauma centers and the American Burn Association for burn centers.



For the record linkage: Each list was linked to the Homeland Security Infrastructure Program (HSIP) Gold 2010 hospital dataset then to the American Hospital Association (AHA) hospital data base using Link Plus software from CDC. The link to the AHA data provided critical information about each hospital for current and future analyses; whereas the HSIP data set provided a more accurate location as well as the locations of multiple hospitals within a system described with only one record in the AHA database. Unlinked records were linked manually and discrepancies were resolved using the respective hospital websites.

Link Plus is a probabilistic record linkage program developed at CDC's Division of Cancer Prevention and Control in support of CDC's National Program of Cancer Registries (NPCR). It is an easy-to-use, standalone desktop application for Microsoft® Windows® that can run in two modes:

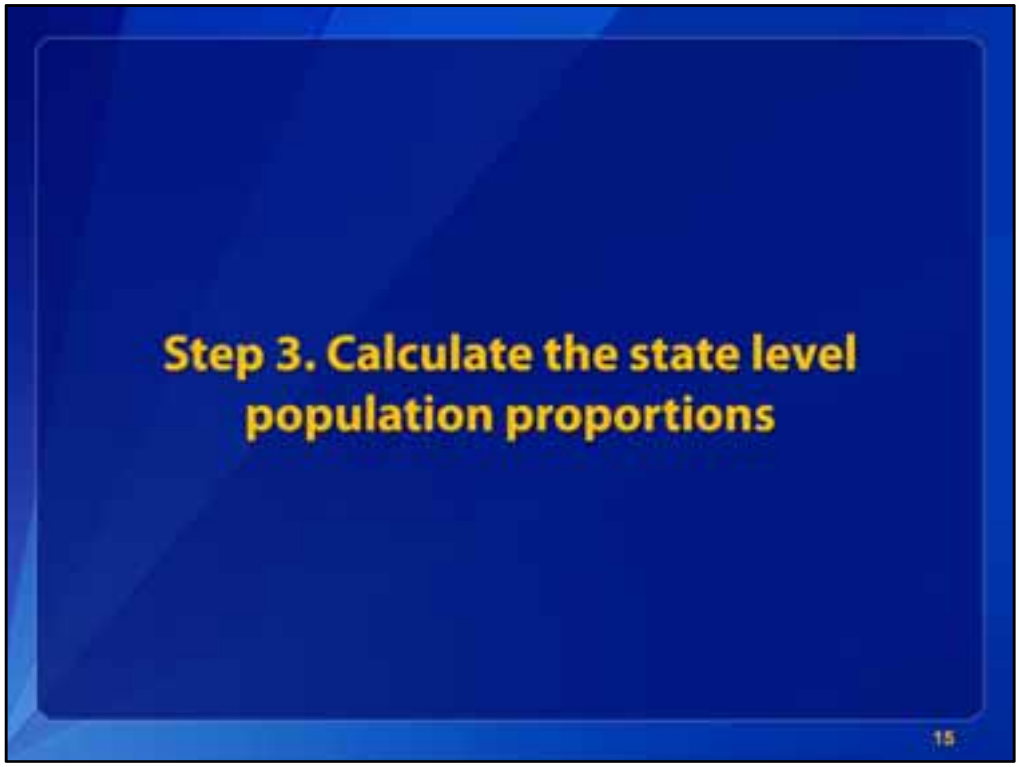
- To detect duplicates in a database.
- To link a file with external files.

Although originally designed to be used by cancer registries, the program can be used with any type of data in fixed width or delimited format. Used extensively across a diversity of research disciplines, Link Plus is rapidly becoming an essential linkage tool for researchers and organizations that maintain public health data.

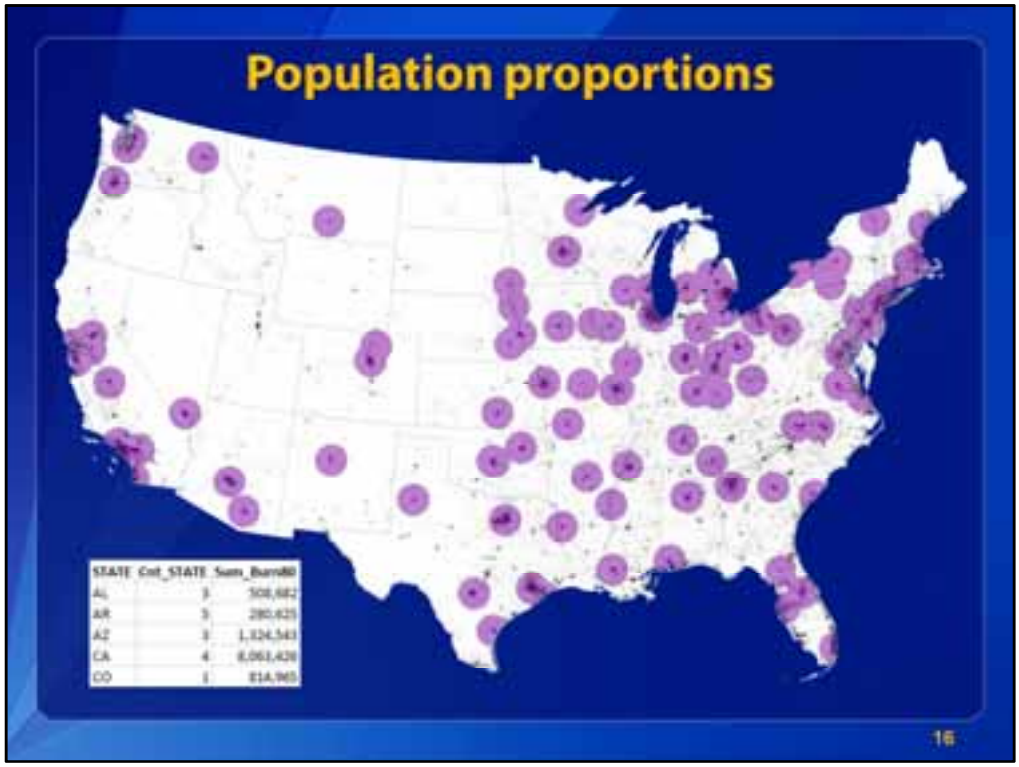
Another ArcGIS Model was used to place Euclidean distance buffers around each hospital at 50 and 100 miles. Buffer zones that overlapped were merged to form confluent zones of hospitals within 50/100 miles of each other.

Fifty miles is an approximation for the “golden” hour as referenced by most trauma specialists as the need to get severely injured persons from the accident scene to a trauma center within an hour to achieve an optimal recovery outcome. One hundred miles is twice that distance, and appears to be the farthest distance most people are willing to travel to get any type of specialized medical care[9-11]. Most medical providers agree that 100 miles is too far to travel for any type of critical medical care.

The hospital zones were then clipped to the state boundaries, so the populations within the zones could be summarized by state.

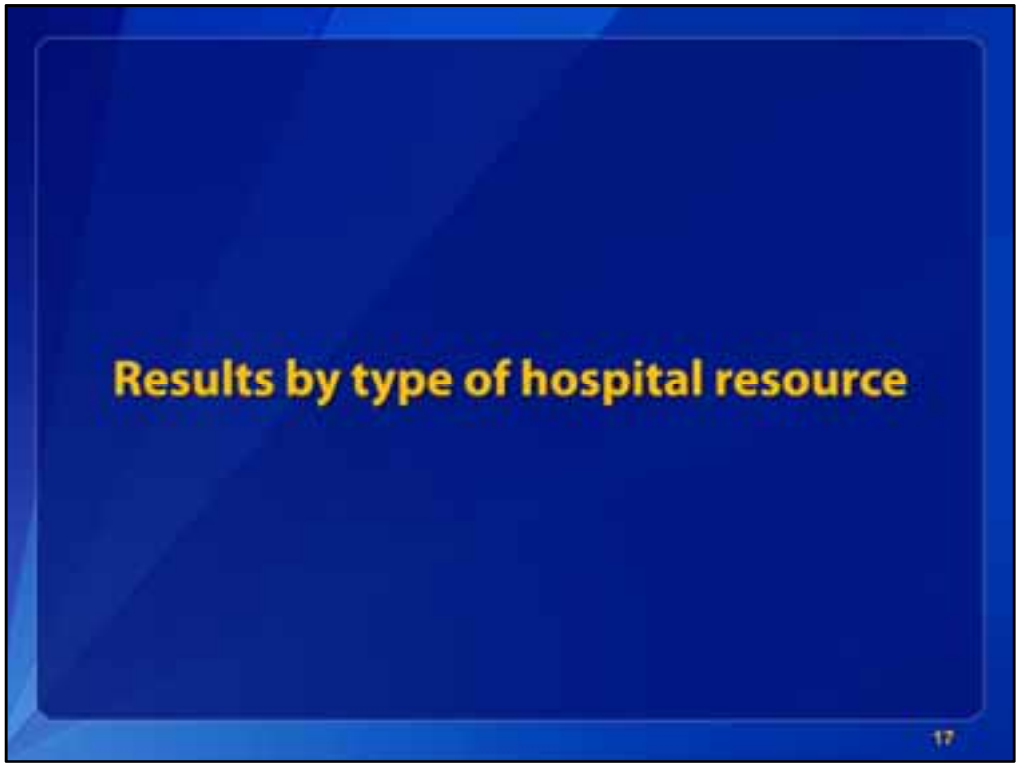


By bringing the population layers and hospital layers together; and evaluate by state.

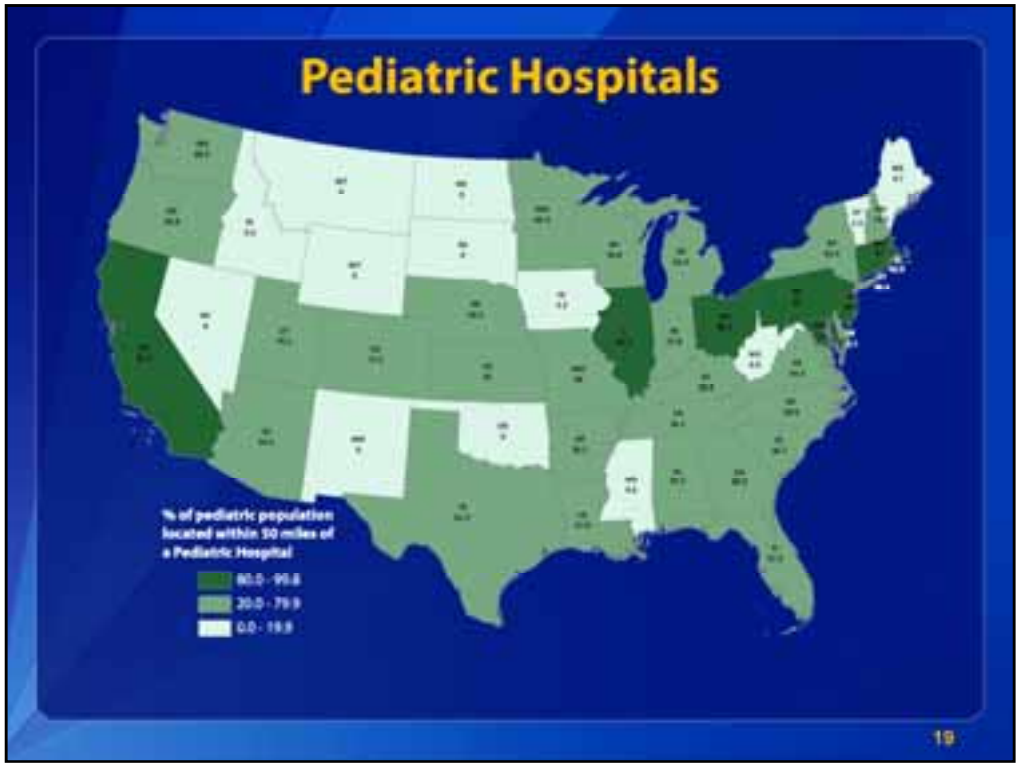


After the buffer zones were split by state, the “zonal statistics as table” tool in ArcGIS was used to calculate the proportion of the pediatric population located inside all zones within each state yielding the number of that state’s pediatric population residing within the critical distance of each type of hospital resource.

Each one of these took 22-28 hours to run.

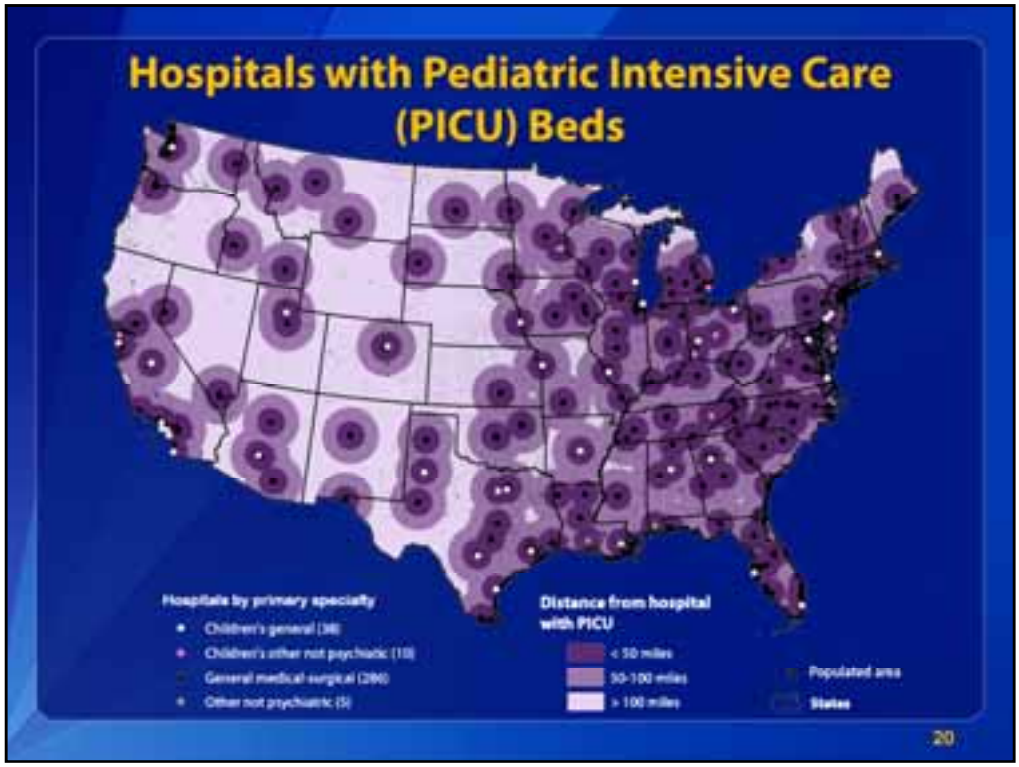

Results by type of hospital resource
17

Nationally, 64.1% of the pediatric population live within 50 miles of a pediatric hospital.

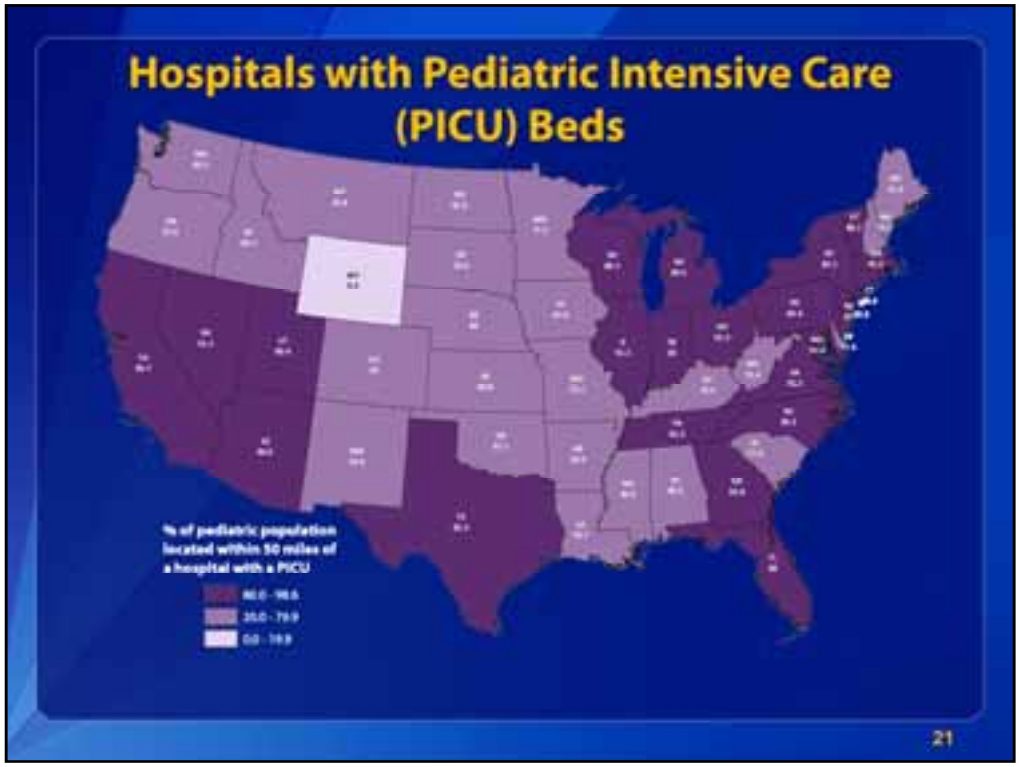


In 10 states (DC, CA, IL, OH, PA, MD, NJ, MA, CT, and RI), 80% or more of the pediatric population lives within 50 miles of a pediatric hospital;
and in 13 states, less than 20% of the pediatric population live within 50 miles of a pediatric hospital.

The range by state is from < 1% to greater than 99%.

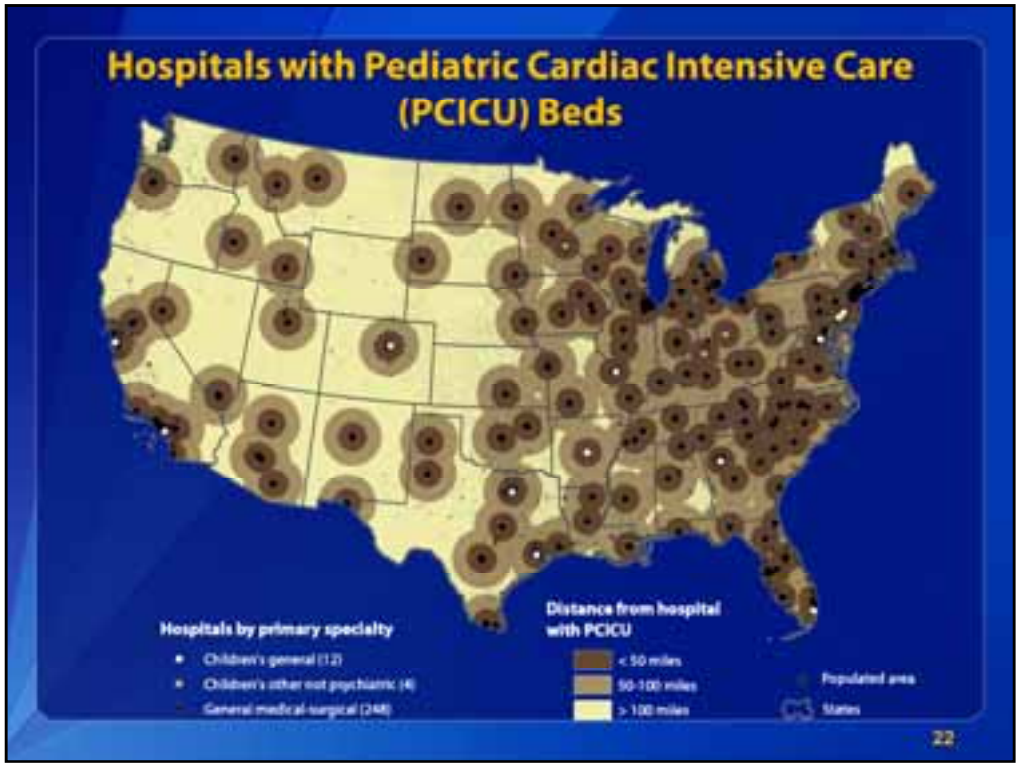


Nationally, 82.0 % of the pediatric population live within 50 miles of a hospital that has a pediatric intensive care unit (PICU);

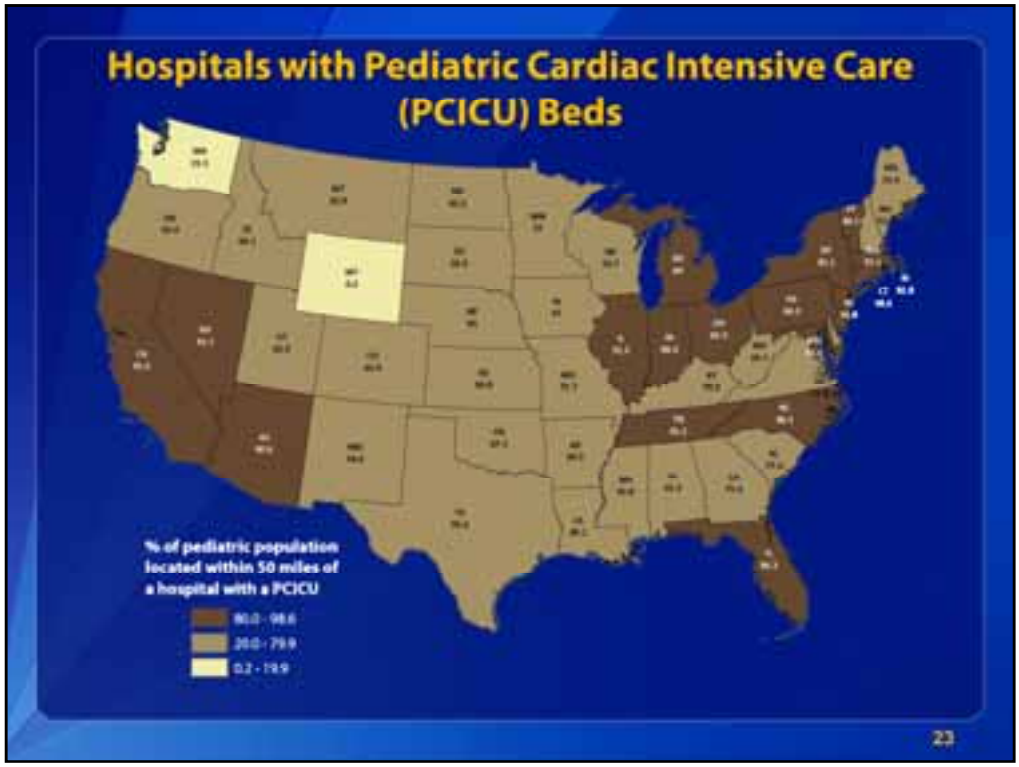


In 24 states, 80% or more of the pediatric population live within 50 miles of a hospital with a pediatric intensive care unit (PICU); and in only 1 state (WY), do less than 20% of the pediatric population live within 50 miles of a hospital with a PICU.

The range by state is from < 1% to 98.6%.



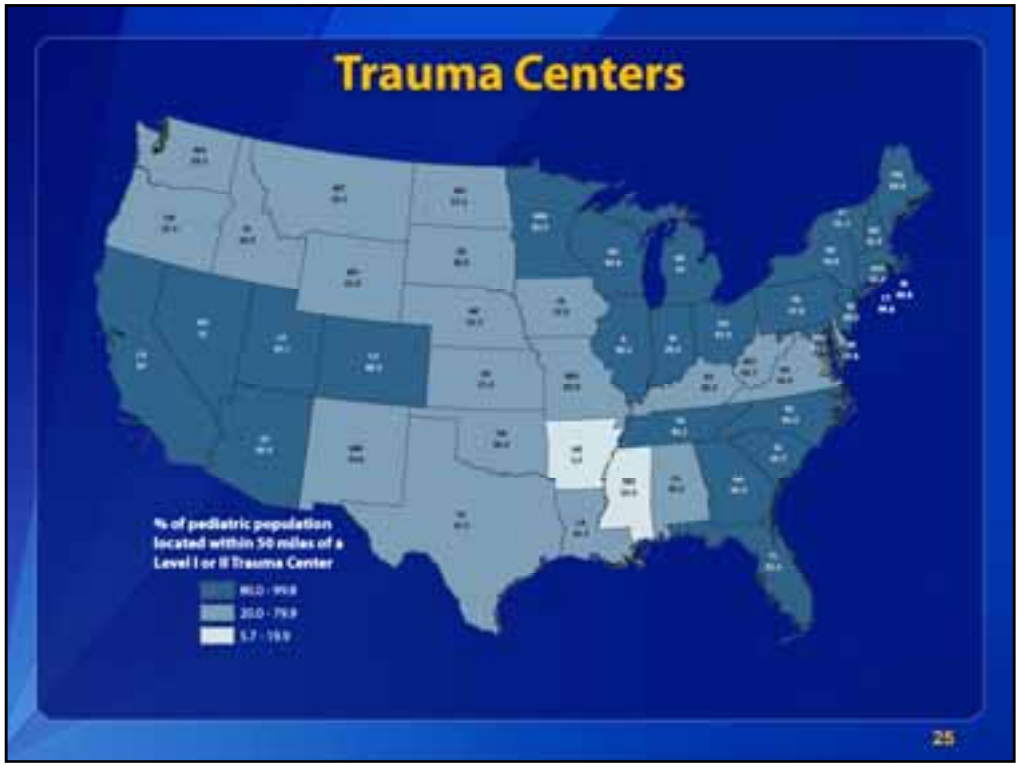
Nationally, 76.6% of the pediatric population live within 50 miles of a hospital that has a pediatric cardiac intensive care unit (PCICU).



In 19 states, 80% or more of the pediatric population live within 50 miles of a hospital with a pediatric cardiac intensive care unit (PCICU); and in only 2 states (WA and WY), do less than 20% of the pediatric population live within 50 miles of a hospital with a PCICU.

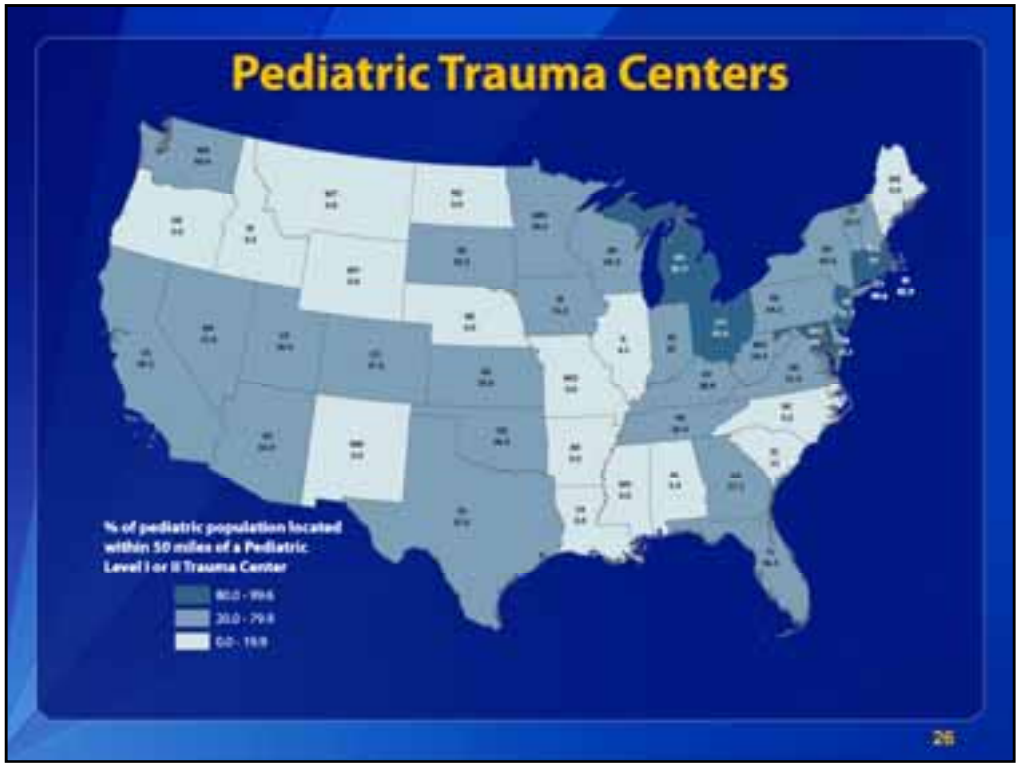
The range by state is from < 1% to 98.6% for hospitals with PCICUs.

Nationally, 80.7% of the pediatric population live within 50 miles of a Level I or II Trauma center; but only 53.4% live within 50 miles of a pediatric trauma center.



In 26 states more than 80% of the pediatric population live within 50 miles of a trauma center; but in 2 states (AR and MS), only 20% or less of the pediatric population live within 50 miles of a Trauma center.

The range by state is from 5.7% to greater than 99% for trauma centers



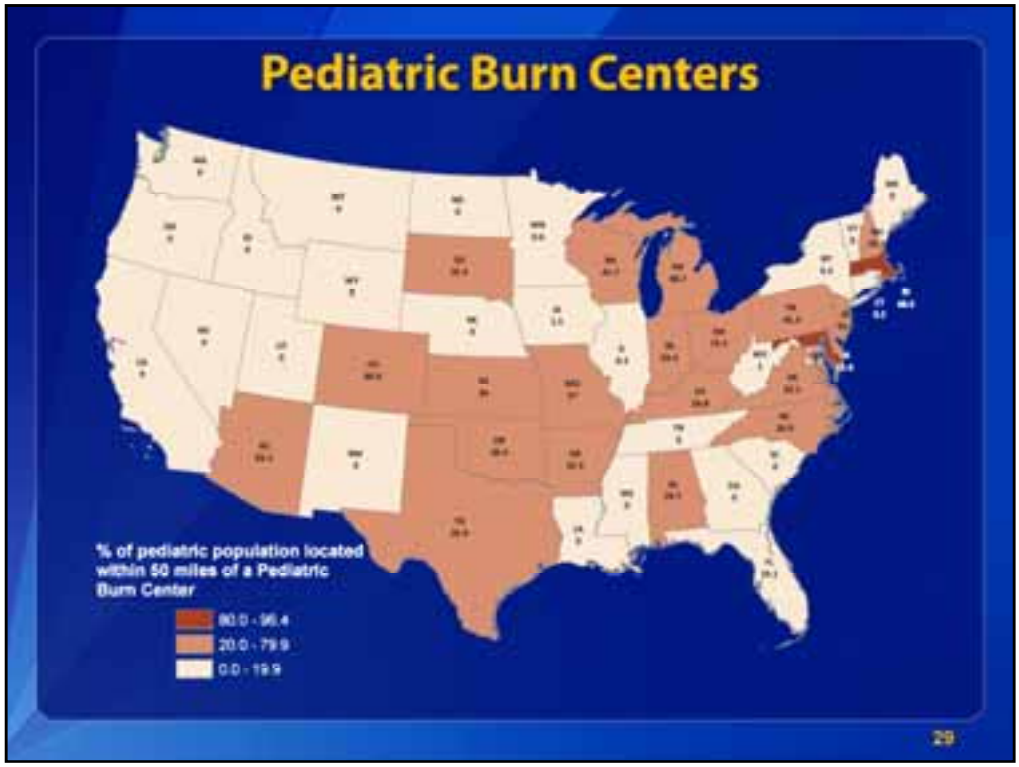
There are 8 states (DC, MI, OH, MA, CT, RI and MD) where more than 80% of the pediatric population live within 50 miles of a pediatric trauma center; and in 16 states, 20% or less of the pediatric population live within 50 miles of a pediatric burn center.

The range is from < 1% to greater than 99%.

Nationally, 71.2 % of the pediatric population live within 50 miles of a burn center; but only 26.4% live within 50 miles of a pediatric burn center.

Only 11 states (DC, CA, IL, MI, OH, NY, MA, CT, RI, NJ, MD) have 80% or more of the pediatric population living within 50 miles of a burn center, and in 4 states (ID, MT, WY, and ND) less than 20% of the pediatric population lives within 50 miles of a burn center.

The range is from < 1% to 99.8%.



There are only 3 states (DC, MA, and MD) where more than 80% of the pediatric population live within 50 miles of a pediatric burn center; and in 25 states, 20% or less of the pediatric population live within 50 miles of a pediatric burn center.

The range is from <1% to 96.3%

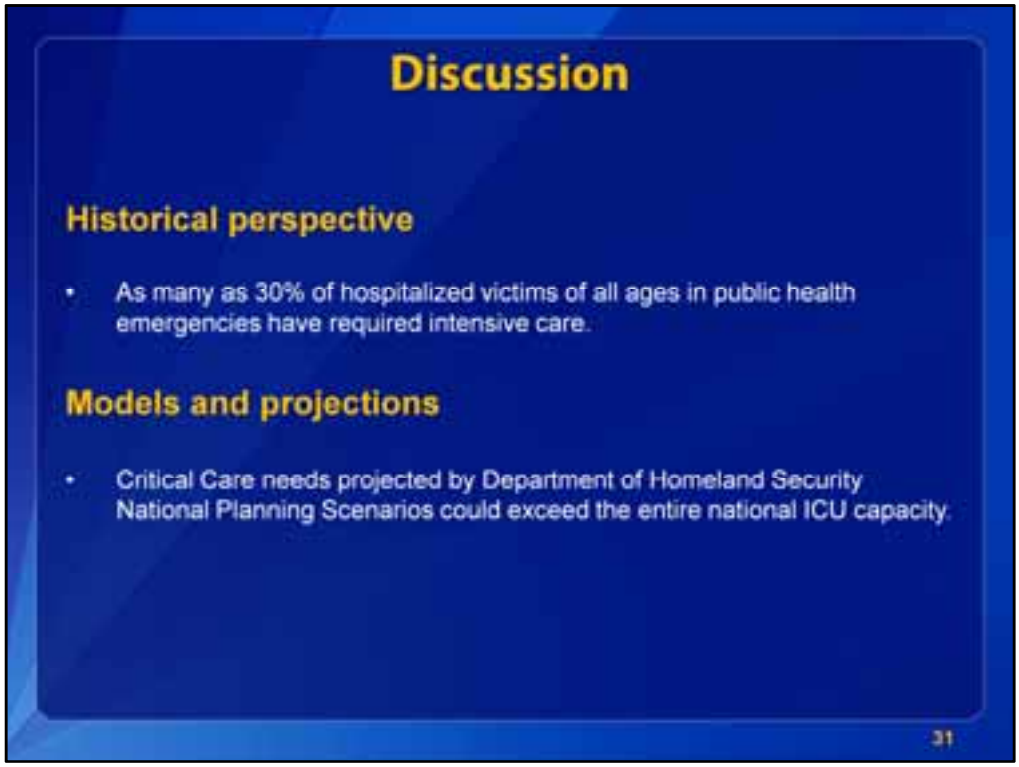
Summary of Results

- Nationally, 80.2% of the pediatric population lives within 50 miles of a Level I or II Trauma center; 70.8 % live within 50 miles of a burn center; 63.7 % live within 50 miles of a pediatric hospital; 81.5 % live within 50 miles of a hospital that has a pediatric intensive care unit (PICU); and 76.1 % live within 50 miles of a hospital that has a pediatric cardiac intensive care unit (PCICU).

- However, state specific proportions have a variability from 5.7% to greater than 99% for trauma centers; from < 1% to greater than 99% for burn centers; from < 1% to greater than 99% for pediatric hospitals; from <1% to greater than 98.6% for hospitals with PICUs; and from <1% to greater than 98.6% for hospitals with PCICUs. Regionally, the eastern half of the country has better overall coverage; while many western states have large areas with no local coverage.

- Restricting the burn and trauma centers to pediatric units only, decreases the proportions even more—only 26.3% of the US pediatric population lives within 50 miles of a pediatric burn center, and only 53.1% live within 50 miles of a pediatric trauma center.

30



Historically, as many as 30% of hospitalized victims of all ages in public health emergencies have required intensive care[14-16].

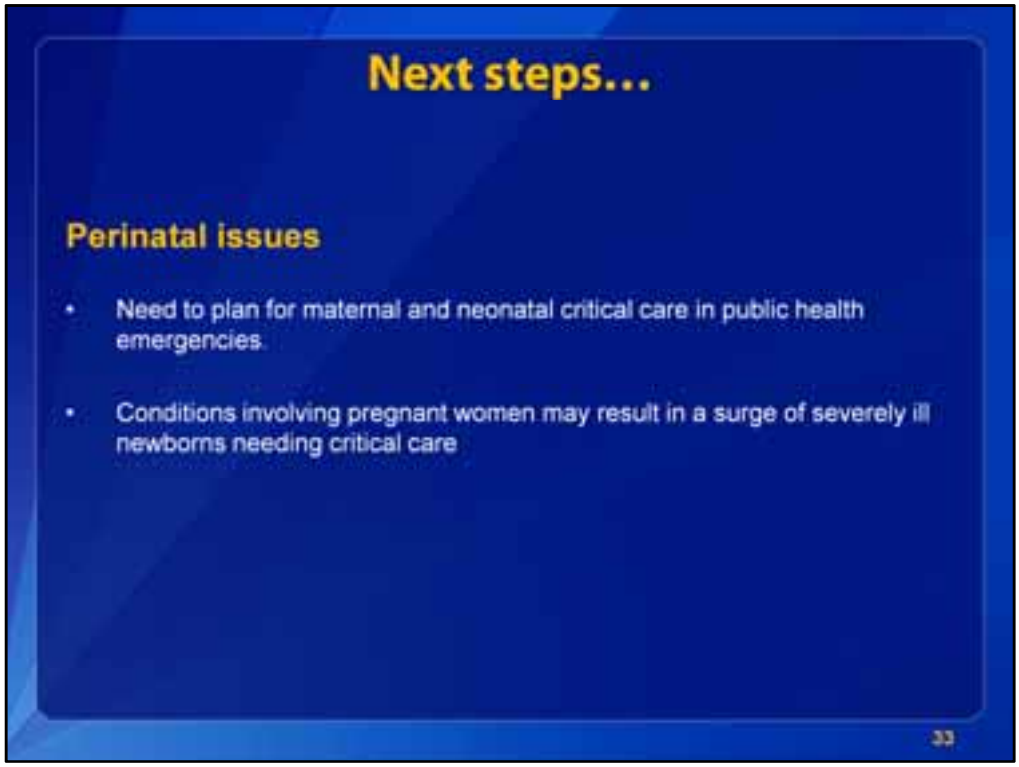
Critical Care needs projected by Department of Homeland Security National Planning Scenarios could exceed the entire national ICU capacity[12].

Because infants and young children are physiologically and behaviorally vulnerable, they may be overrepresented in a public health emergency.

Pediatric needs may predominate in emergencies involving a pathogen targeting infants, children, or pregnant women [17].

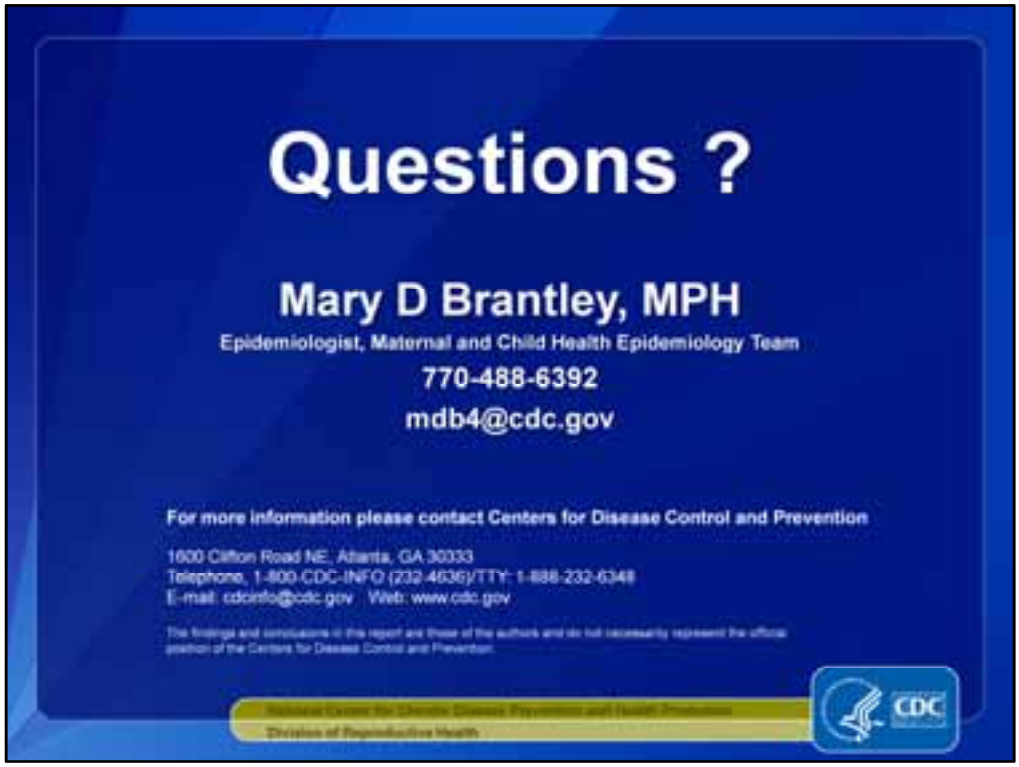
An accident involving schools or other pediatric-specific activities, or terrorism specifically targeting children, would result in surges of children disproportionate to the overall population [18, 19].

Whatever proportion of a surge is made up of children, planners should anticipate that a disproportionate number of the children needing intensive care are vulnerable by virtue of chronic health conditions and special health care needs.



Far less attention has been given to planning for maternal and neonatal critical care than pediatric and adult critical care in public health emergencies.

However, recent experience with the H1N1 pandemic indicates that conditions involving pregnant women may result in a surge of severely ill newborns needing critical care[13]


Questions ?
Mary D Brantley, MPH
Epidemiologist, Maternal and Child Health Epidemiology Team
770-488-6392
mdb4@cdc.gov
For more information please contact Centers for Disease Control and Prevention
1600 Clifton Road NE, Atlanta, GA 30333
Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: www.cdc.gov
CDC

References

[1] Pollack MM, Alexander SR, Clarke N, et al; Improved outcomes form tertiary center pediatric intensive care: A statewide comparison of tertiary and nontertiary care facilities. Crit Care Med. 1991;19:150-159

[2] Tilford JM, Simpson PM, Green JW, Lensing S, Fiser D; Volume-outcome relationships in pediatric intensive care units. Pediatrics. 2000;106:289-294.

[3] Osler TM, Vane DW, Tepas JJ, Rogers FB, Shackford SR, Badger GJ; Do pediatric trauma centers have better survival rates than adult trauma centers? An examination of the National Pediatric Trauma Registry. J Trauma. 2001;50:96-101.

[4] Densmore JC, Lim HJ, Oldham KT, Guice KS; Outocmes and delivery of care in pediatric injury. J Pediatr Surgery 2006;41:92-8.

[5] Petrosyan M, Guner YS, Emami CN, Ford HR: Disparities in the delivery of pediatric trauma care. J Trauma. 2009;67:S114-119.

[6] Hartman M, Watson RS, Linde-Zwirble W, Clermont G, Lave J, Weissfeld L, Kochanuk P, Angus D; Pediatric traumatic brain injury is inconsistently regionalized in the United States. Pediatrics 2008; 122:e172.

35

References conti…..

[7] Kanter RK; Regional variation in child mortality at hospitals lacking a pediatric intensive care unit. Crit Care Med 2002; 30:94.

[8] Bravata DM, et al; Regionalization of bioterrorism preparedness and response. AHRQ No 04-E016-2. 2004.

[9] Nicole Yantzi, Mark W. Rosenberg, Sharon O. Burke and Margaret B. Harrison, The impacts of distance to hospital on families with a child with a chronic condition, Social Science & Medicine, Volume 52, Issue 12, June 2001, Pages 1777-1791

[10] Lee R Mobley, Ted Frech, 1998. "Managed Care, Distance Traveled, and Hospital Market Definition," University of California at Santa Barbara, Economics Working Paper Series 13-98, Department of Economics, UCSB.

[11] Chang, Ruey-Kang R., Klitzner, Thomas S. Can Regionalization Decrease the Number of Deaths for Children Who Undergo Cardiac Surgery? A Theoretical Analysis, Pediatrics 2002 109: 173-181

References conti…..

[12] Task Force for Mass Critical Care Summit Meeting; Chest 2008;133:1S-66S.

[13] Louie JK, Acosta M, Jamieson DJ, Honein MA, and the California Pandemic (H1N1) Working Group. N Engl J Med. 2009; doi 10.1056/NEJMoa0910444.

[14] Aharonson-Daniel L, Waisman Y, Dannon YL, et al; Epidemiology of terror-related versus non-terror-related traumatic injury in children. Pediatrics. 2003;112:e280.

[15] Centers for Disease Control and Prevention. Predicting casualty severity and hospital capacity. Atlanta, GA, 2003. Available at: http://www.bt.cdc.gov/masscasualties/capacity.asp. Accessed January 6, 2010.

[16] Peleg K, Aharonson-Daniel L, Stein M, et al; Gunshot and explosion injuries: Characteristics, outcome, and implications for care of terror-related injuries in Israel. Ann Surg. 2004;239:311-318.

37

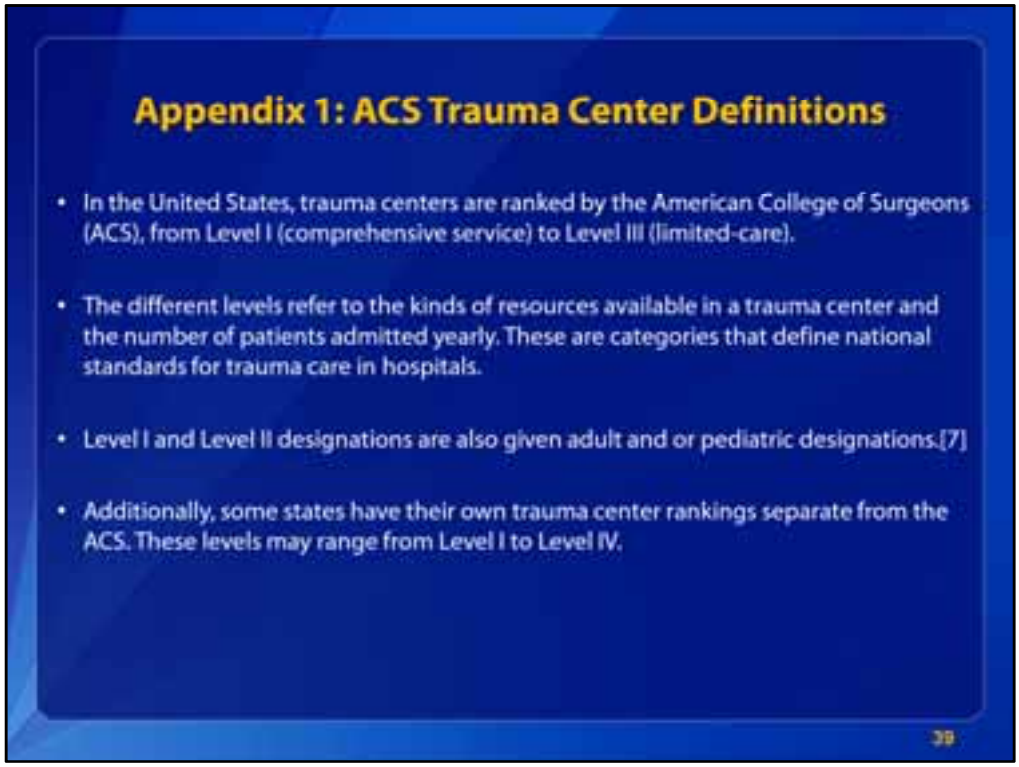
References conti…..

[17] Louie JK, Acosta M, Jamieson DJ, Honein MA, the California Pandemic (H1N1) Working Group. Severe 2009 H1N1 Influenza in pregnant and postpartum women in California. N Engl J Med. 2010;362:27-35.

[18] Graham J, Shirm S, Liggin R, et al; Mass-casualty events at schools. Pediatrics. 2006;117:8-15.

[19] Markenson D, Reynolds S; The pediatrician and disaster preparedness. Pediatrics. 2006;117:e340-362.

38


Appendix 1: ACS Trauma Center Definitions
• In the United States, trauma centers are ranked by the American College of Surgeons (ACS), from Level I (comprehensive service) to Level III (limited-care).
• The different levels refer to the kinds of resources available in a trauma center and the number of patients admitted yearly. These are categories that define national standards for trauma care in hospitals.
• Level I and Level II designations are also given adult and or pediatric designations.[7]
• Additionally, some states have their own trauma center rankings separate from the ACS. These levels may range from Level I to Level IV.
39

Appendix 1: ACS Trauma Center Definitions

Level I

Level I

A Level I trauma center provides the highest level of surgical care to trauma patients. It has a full range of specialists and equipment available 24 hours a day and admits a minimum required annual volume of severely injured patients. A Level I trauma center is required to have a certain number of surgeons and anesthesiologists on duty 24 hours a day at the hospital, an education program, preventive and outreach programs. Key elements include 24-hour in-house coverage by general surgeons and prompt availability of care in varying specialties such as orthopedic surgery, neurosurgery, plastic surgery (plastic surgeons often take calls for hand and facial injuries fixing both the bone and soft tissue of these specialized regions), anesthesiology, emergency medicine, radiology, internal medicine, oral and maxillofacial surgery, and critical care, which are needed to adequately respond and care for various forms of trauma that a patient may suffer. Additionally, a Level I center has a program of research, is a leader in trauma education and injury prevention, and is a referral resource for communities in nearby regions.[8]

Level I trauma center hospitals in most states in the U.S. (New York, and Pennsylvania among others are notable exceptions) are designated by the American College of Surgeons (ACS) for a period of three years. Pennsylvania has its own rankings system, based on the criteria of the Commonwealth's Trauma Foundation.

The ACS does not officially designate hospitals as regional trauma centers, however. Numerous U.S. hospitals that are not listed on the organization's trauma roster nevertheless refer to their emergency or trauma units as "Level I trauma centers." The ACS describes that responsibility as "a geopolitical process by which empowered entities, government or otherwise, are authorized to designate." The ACS's self-appointed mission is limited to confirming and reporting on any given hospital's ability to comply with the ACS standard of care known as Resources for Optimal Care of the Injured Patient.[9]

40

Appendix 1: ACS Trauma Center Definitions

Level II through Level IV

Level II

A Level II trauma center works in collaboration with a Level I center. It provides comprehensive trauma care and supplements the clinical expertise of a Level I institution. It provides 24-hour availability of all essential specialties, personnel, and equipment. Minimum volume requirements may depend on local conditions. These institutions are not required to have an ongoing program of research or a surgical residency program.[8]

Level III

A Level III trauma center does not have the full availability of specialists, but does have resources for emergency resuscitation, surgery, and intensive care of most trauma patients. A Level III center has transfer agreements with Level I or Level II trauma centers that provide back-up resources for the care of exceptionally severe injuries, Example: Rural or Community hospitals.[8]

Level IV

A Level IV trauma center exists in some states where the resources do not exist for a Level III trauma center. It provides initial evaluation, stabilization, diagnostic capabilities, and transfer to a higher level of care. It may also provide surgery and critical care services as defined in the scope of services of trauma care. A trauma trained nurse is immediately available, and physicians are available upon the patients arrival to the Emergency Department. Transfer agreements exist with other trauma centees with higher levels when conditions warrant a transfer.

41

Appendix 2: Burn Center Verification

American Burn Association and American College of Surgeons

Verification of burn centers is a joint program of the American Burn Association (ABA) and the American College of Surgeons (ACS). It is a rigorous review program designed to verify a burn center's resources that are required for the provision of optimal care to burn patients from the time of injury through rehabilitation. Elements of this voluntary program include an application, pre-review questionnaire, an in-depth on-site review by members of the ABA Verification Committee, as well as senior members of the ABA. A written report of the site visit team is reviewed by the ABA Verification Committee and by the Committee on Trauma of the ACS.

Burn Center verification provides a true mark of distinction for a burn center. It is an indicator to government, third-party payers, patients and their families, and accreditation organizations that the center provides high quality patient care and meets the demanding standards for organizational structure, personnel qualifications, facilities resources and medical care services set out in the ABA chapter on Guidelines for the Operation of Burn Centers in the ACS publication on Resources For Optimal Care Of The Injured Patient 2006.

http://www.ameriburn.org/verification_verifiedcenters.php

42