The Impact of Changing Public Policy on California's Hospital Infrastructure and Children's Hospital Outcomes - 1983-2000

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ADE	Adverse Drug Event
AHDR	Annual Hospital Disclosure Reports
CHOW	Change of Ownership
CMS	Centers for Medicare and Medicaid Services
CQI	Care Quality Indicators
DRG	Diagnostic Related Groups
ELOS	Extended Length of Stay
EMTALA	Emergency Medical Treatment and Labor Act
ER	Emergency Room
FFS	Fee for Service
GACH	General Acute Care Hospitals
GSP	Gross State Product
HSA	Health Service Agency
HFPA	Health Facilities Planning Area
HRSA	Health Resources and Services Administration
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
ICU	Intensive Care Unit
IOM	Institute of Medicine
MC	Managed Care
MD	Medical Doctor
MSA	Medical/Surgical Acute care
NRD	Non-routine Discharge
OOC	Out-of-County
OPSN	Outcomes Potentially Sensitive to Nursing
OSHPD	Office of Statewide Health Planning and Development
PAC, PACU	Pediatric Acute Care (Unit)
PDD	Patient Discharge Data
PIC, PICU	Pediatric Intensive Care (Unit)
PPS	Prospective Payment System
SPA	Service Provider Area
TDS	Total Daily Service

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In 1988, the Institute of Medicine (IOM) published its landmark study, The Future of Public Health.[1] This report presented strong evidence that the public health system -- the organizational mechanism for achieving the best population health -- was in disarray. In 2003, the IOM revisited this theme, strengthened their emphasis on population health, and found conditions more dire.[2] They promote the concept of health as a public good that the government has a fundamental duty to promote and protect. It is in this spirit that we direct this report to those most responsible for strengthening California's public healthcare system for children.

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1 The Future of Public Health. Institute of Medicine (IOM) National Academy Press, Washington, DC. 1988. Accessed 17 Mar 2004 at: http://www.nap.edu/books/0309038308/html/index.html

2 The Future of the Public's Health in the 21st Century. Institute of Medicine, Nov. 2002. Accessed 25 Nov 2002 at: http://www.nap.edu

INTRODUCTION

THE LANDSCAPE OF HEALTHCARE ISSUES FOR CHILDREN

The demographics of California's child population changed dramatically after 1983. The percent of infants born to non-Hispanic White women decreased from 54% to 32% of the newborn population. By 2000, 50% of infants born in California had Hispanic mothers, 27% of whom were born in Mexico, and 29% of whom had no high school degree.[1] In addition, by 2000, 26% of Californian's lived in immigrant families,[2] compared with 11% nationally.[3] According to the Public Policy Institute of California,[4] the percent of families with incomes below the poverty level rose from 9.1% in 1969 to 13.1% in 2000, compared to 11.9% nationally, moving California's ranking from 30 (below median) to 14 (high), with poverty rates growing faster here than elsewhere in the nation. About 1 in 5 children live in poverty. California's poverty ranking was slightly below the national average in 1969 and rose to 2nd in 2000 at 24.3%, with only the District of Columbia higher. Poverty rates are now double or higher for foreign-born residents and for Hispanics, African Americans, Native Americans, and Southeast Asians. These changes indicate large increases in children at greater risk for poor health status and poor access to care.

Concern by advocates and policy makers about access to healthcare for California's vulnerable children led to a series of Medicaid expansions between 1984 and 1990 that resulted in many more poor children becoming eligible for publicly funded health insurance. By 1990, eligibility was extended to children up to 19 in very low income families and children under 6 in families with incomes up to 133% of poverty. Through California's Child Health and Disability Prevention Program, health screening, diagnostic and treatment coverage was extended to young children in families with incomes up to 200% of poverty. In 1997 California began to implement the Healthy Families Program, California's version of the federal State Child Health Insurance Program, which extended coverage to children up to age 19 living in families with income levels below 200% of poverty. However, by 2001, only 412,433 were enrolled in Healthy Families.[5]

A series of budgetary and policy decisions offset some of the benefits of insurance expansions, in both the public and the private sectors. In an effort to decrease escalating health care costs, insurers began to implement parallel strategies: Payment by Diagnostic Related Groups (DRG), the Prospective Payment System (PPS) or other capitation method to pay for hospital care, and Managed Care (MC). Under the PPS, payment is based on medical conditions classified by the DRG embedded in the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM).[6] These fundamental reforms were a major shift away from fee-for-service (FFS) payment and created incentives to provide less care.

Parallel with the PPS, large private sector payors began to shift from FFS into MC with payment by DRG or other capitated models. In 1994, most of California's large employers announced their intent to complete the shift from FFS to MC health insurance alternatives effective 1995.[7] The transition to MC has been slower in the public sector. By 2001, only 51% of MediCal recipients were in MediCal MC models.[5 8]

Other policy decisions countered some effects of the MediCal expansions. The most important was welfare reform, which unlinked eligibility for welfare and MediCal.[9 10] This was associated with a 30% drop in MediCal coverage within 6 months of leaving cash assistance. The second major challenge was a series of attempts to cut services to undocumented immigrants.[11 12] Although the courts ultimately set aside most efforts to exclude immigrants, the effect was to discourage many from enrolling in public insurance programs.

As these conflicting reforms were implemented -- one set to increase access to insurance, the other resulting in decreased access to care -- the percent of children with employer-based insurance decreased nationally from 74% to 66% between 1989 and 1995.[13] By 2001, the percent of children with employer-based insurance was 61% nationally, and in California, 55%.[14] The negative effects of employer withdrawal were somewhat mitigated by expanding Medicaid benefits for low-income families.[15] Despite expansions, 15% of California children remain uninsured,[16] a figure essentially unchanged since 1980.[17] [18] [19] Today the public pays for half of all California births and pediatric hospitalizations.[1]

Further cost saving measures resulted in MediCal providers being the lowest paid in the nation.[20] California's MediCal providers are reimbursed at 30% of the rate paid to providers for private patients.[21] Half of California physicians now refuse to serve MediCal patients, while nationally only 15% of physicians refuse to serve such patients.[22]

During this period a series of legislative and policy decisions further compromised the potential benefits of expanded insurance coverage for childrenthrough their effects on the healthcare infrastructure. . The purpose of this report is to describe these structural changes and to examine their impact on access to and outcomes of hospital care for children age 30 days to 13 years.

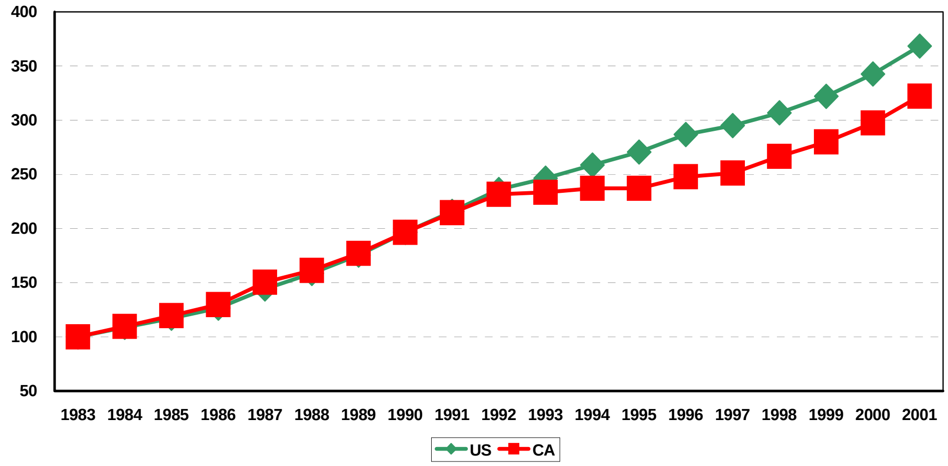
POLICIES AFFECTING HEALTHCARE INFRASTRUCTURE

In the 1970s, California passed comprehensive legislation to create a framework to control hospital costs yet protect patient safety. The legislation required an inventory of health facilities, planning processes including regional Health Service Areas (HSA), local Health Facilities Planning Areas (HFPA), and Certificates of Need to justify closures or service expansions, development of data systems to monitor utilization, costs, and expenditures and safety-related policies to monitor hospital structures, processes of care, and patient care.[23] [24] Responsibilities for building safety, planning, and data systems was delegated to the Office of Statewide Health Planning and Development (OSHPD). Monitoring patient safety (licensing and certifying facilities, investigating and resolving complaints, educating health care workers) was assigned to the Department of Health Services Licensing and Certification.

In 1987, the legislature suspended the Certificate of Need and related planning activities[25] and permitted hospitals to close or consolidate without state review.[26] Personal communication with OSHPD staff and others revealed that this was a response to intense hospital industry lobbying. Unlike states that kept Federal planning requirements in place, California deregulated its healthcare system, finding it "indispensable that providers of health care be free to engage in voluntary, cooperative efforts with consumers, government, or other providers of health care to fulfill the purposes of the health planning laws."[27]

Shifting public attention toward insurance expansions and away from planning and cost controls increased California's health insurance expenditures and reduced healthcare services expenditures. Between 1983 and 2004, the percent of California's Gross State Product (GSP) devoted to health services remained steady at 4.7% while comparable federal spending rose from 4.7% to 5.8%.[28] Figure 1 shows that since 1990, California's percent change in health services GSP has been well below the national average.[29]

Figure 1. Percentage Change in Health Services GSP over 1983 in 2002 Dollars



Reducing health services expenditures had a significant detrimental impact on California's economic health.[30] The Bureau of Economic Analysis identified that California's long recovery from the 1990-1991 recession is due in part to continuing weaknesses in its health services and insurance sectors.[31] Today, only three states -- Nevada, Wyoming, and the District of Columbia -- spend a smaller percent of their budget on health services.[32]

IMPACT ON THE HEALTHCARE INFRASTRUCTURE

Since 1983, the primary health services cost-reduction strategy has been to reduce structural capacity investment, both hard (hospitals) and soft (personnel). These reductions were accomplished primarily by administratively driven activities such as closures, consolidations, and ownership changes that followed mergers, acquisitions, conversions, and joint ventures.

Between 1990 and 2000 the GAO reported that California had a net loss of 58 hospitals, 6th highest among the states for rural closures, and leading in urban closures.[33 34] In 1995 alone, 43 mergers and purchases occurred in California, the highest number in the nation.[35] Most conversions have been public to non-profit, even though most research focused on non-profit to investor conversions.[36] More than 90 percent of ownership changes occurred in urban areas, where hospital systems established a strong presence.[37] By 2001, these systems owned 39% of 494 hospitals California monitors.[38]

These business strategies did not result in lower health costs as promised but rather in higher prices and higher profits. Krishna found that Ohio and California hospitals involved in mergers and acquisitions increased prices to a greater extent than non-merging hospitals.[39] Another study of California mergers found that nonprofit mergers could result in price increases of up to 26%.[40] The California Public Employees Retirement System found charges at one hospital chain are 80 percent higher than the state average, and the chain uses its Northern California market dominance to force contracts with all their 26 hospitals.[41]

As California's largest hospital corporations consolidated market power, executive salaries, legal expenses, and ownership of privately held investor corporations including offshore holdings skyrocketed.[42 43 44] California's hospital industry reaped record profits of more than $2.7 billion in 2002.[45] In 2003, one nonprofit hospital system alone had profits of $359 million, reflecting a 6.8% operating margin, while the nation's top-performing nonprofit hospital chains typically hit margins around 2-3%.[46] To counter system-wide efforts to maintain monopolies, hide hospital costs, and increase charges, Senator Dede Alpert introduced SB 1509 to improve public disclosure regarding both costs and quality.[47]

The Health Resources and Services Administration (HRSA) compared key infrastructure indicators for California and the US as of December 2000, a date coinciding with the end of the period covered by this study.[48] Table 1 summarizes some of the HRSA findings. Although California ranks 15th nationally for physicians per population, it is among the worst for most other important infrastructure indicators per 100,000 population.

Table 1. Healthcare infrastructure indicators per 100,000 population

Indicator	CA	US	CA Rank
Physicians	195	198	15/50
Primary care physicians	62	59	18/50
Hospital beds	228	311	43/50
Health Services jobs	3,104	4,127	48/50
Hospital employment	1,247	1,841	48/50
Registered nurses	568	798	50/50
Pharmacists	51	66	48/50
Social workers	140	216	48/50
Physical therapists	34	41	43/50
Radiology technicians	39	58	49/50
Home health aides	71	160	48/50

In addition to being at or near the bottom among states in access to important healthcare infrastructure, these resources are distributed unequally across California's areas and populations. For example:

- The number of primary care physicians per 100,000 population is 146 in Marin County, 86 in Contra Costa County, and 60 in Kern County.[49]
- Only three California areas meet or exceed the national average of RNs per capita, with Contra Costa and Santa Cruz counties having the fewest RNs nationally.[50]
- Nationally, 527 hospitals in 46 states (10% of US hospitals) were cited one or more times between 1996 and 2000 for violating the federal Emergency Medical Treatment and Labor Act (EMTALA), or "patient dumping."[51] This included 78 California facilities (15% of California hospitals). Penalties, which reflect EMTALA violation severity, have been increasing in number and in amount. Nationally, 30% of cited hospitals paid civil monetary penalties; in California, 44%.
- Large portions of California lack immediate access to high level trauma centers, and the 42 existing centers maintain records so flawed that advocates cannot determine how much funding is needed to keep the system operating.[52]

California's underinvestment in its health services workforce has produced an interrelated set of workforce problems including personnel shortages, soaring staff turnover, and increased use of temporary personnel to deliver patient care. Individually and together, these factors diminish quality of patient care.[53 54 55] They also increase costs to hire and train replacement workers.[56 57]

IMPACT OF INFRASTRUCTURE ON PATIENT OUTCOMES

In this rapidly changing environment, the Institute of Medicine estimated that 750,000 to slightly over a million adverse hospital events occurred annually.[58 59] The most common are related to medications, procedures, and operative-related problems. Recent studies suggest the IOM may have underestimated the problem.[60 61] Respected healthcare professionals have come to believe that changes in the healthcare system have contributed to an unacceptable and alarming incidence of medical errors and compromised the safety and quality of care.[62 63 64 65]

In seeking to understand why these events were occurring, some outcomes potentially sensitive to nursing (OPSN) have been established in the literature.[66 67 68 69] These include complications of care, extended length of stay (ELOS), and non-routine discharges (NRD). Such studies consistently have found that increased OPSN were associated with moving from high to low values for nurse staffing ratios.

Nurses are not the only caregivers whose availability has been found to impact patient outcomes. Mortality rates decrease with increased staffing levels for medical residents, registered nurses, registered pharmacists, medical technologists, and total hospital personnel; and increase as staffing level per occupied bed increase for hospital administrators and licensed practical-vocational nurses.[70 71]

Most would agree that hospitals should provide a safe, secure environment for the care of children. In establishing its priorities, the National Summit on Medical Errors and Safety Research developed an agenda that highlighted concerns for children, and particularly children who are members of low income and minority families.[72]

Studies of pediatric outcomes tend to be smaller and narrowly focused. One study found widespread misuse of drugs and under and over use of procedures, including overuse of antibiotics and tympanostomies.[73] Of prospectively studied pediatric tympanostomy patients, 9% experienced a minor adverse event and 1.9% a major adverse event.[74] Unplanned readmissions following otologic surgery occurred two times more often for children than for adults.[75] One study found the rate of medication errors for adults (5.3%) and children (5.7%) to be similar, but the potential adverse drug event (ADE) rate was 3 times higher for children than for adults.[76] Another study found pediatric ADEs occurred at a rate of 6% with 24% life-threatening.[77] Risk factors for pediatric nosocomial infections are related more to processes of care and staffing than to illness severity.[78 79 80] Appropriate team composition and availability of appropriate transport equipment has been shown to reduce serious adverse events during intrahospital transport of critically ill children.[81] Inequalities in rates of potentially avoidable hospitalizations and adverse outcomes may reflect systematic inattention to children's special needs.[82 83 84 85]

Non-clinical structural factors affecting pediatric outcomes have also been identified. Severity-adjusted LOS for pediatric asthma admissions has been found to vary as a function of ownership, location, and teaching status.[86 87] Use by managed care companies of gatekeepers and contractual agreements to use hospitals lacking specialized pediatric capacity have been shown to have adverse effects on child outcomes.[88 89] Distance from hospital, bed supply, and type of hospital has been identified as influences on rates of pediatric hospitalization.[90]

Only a few longitudinal studies have focused on quality outcomes in the pediatric population. A 10-year study of acute-care patients on the medical, surgical, pediatric, and obstetric-gynecologic services in one hospital found nosocomial bloodstream infection increased from 0.0% in 1985 to 2.3% in 1995.[91] A 10-year retrospective analysis on the impact of Medicaid on children's health services found Medicaid improved access to illness-related care among children in low income families but did not improve access to preventive care.[92] A 10-year follow-up of post-operative urinary tract infections associated with bladder catheterization in a pediatric intensive care unit found that infection rates rebounded after the unit abandoned a 48- to 72-hour automatic discontinue order and left catheter use decisions to physician judgment.[80] A longitudinal study of pediatric nosocomial infections in 49 hospitals from 1995 to 2000 found rates were constant at 15% and most major pathogens occurred with relative equal frequency in the intensive care and ward settings.[93] None of these studies looked at the impact of hospital characteristics on indicators of access or outcome, over time or at the local level.

STUDY OBJECTIVES

This study was undertaken to explore the consequences of conflicting health policies and lack of statewide planning on the healthcare infrastructure and health outcomes of California's child population. The specific objectives are to describe state and county level changes in the hospital infrastructure between 1983 and 2000 and to determine whether the changes affected hospital access and outcomes for the pediatric population age 30 days to 13 years.

We describe and evaluate changes in hospital management (ownership type, conversions, consolidations, changes in physical location) and physical capacity (hospitals, emergency rooms (ER), beds). Then we examine the impact of those changes on children's hospital access (insurance, out-of-county admissions, and admission source) and outcomes (adverse care quality indicators, extended length of stay, and non-routine dispositions). The results are expected to provide guidance to the state legislature in evaluating the way health care dollars are allocated and in promulgating regulations to affect hospital infrastructure.

This paper does not examine changes in caregiving personnel (nurses, technicians) or caregiving processes on pediatric outcomes. In developing research methods for this paper, we identified a number of problems with data quality that have yet to be resolved. Data quality issues will be the topic of a separate paper.

METHOD

DATA SOURCES

OSHPD provided the two primary hospital-related data for the years 1983 through 2000. These were the Patient Discharge Data (PDD)[94] and the Annual Hospital Disclosure Reports (AHDR).[95] We supplemented these with information from other resources. A full presentation of the methods used and issues encountered in creating the longitudinal PDD source dataset and the hospital-level AHDR source dataset are available elsewhere.[96 97]

HOSPITALS USED IN THE ANALYSIS

This research focuses on pediatric discharges from general acute care hospitals (GACH). Because we were interested in care of pediatric cases in "true" short-term GACH, we excluded hospitals where the preponderance of evidence indicated the hospital provided mainly specialty care between 1983 and 2000. Of 725 hospitals ever licensed in California between 1983 and 2000, we excluded 253, and tentatively identified 472 as short-term GACH. Of these, 468 had discharged children in the target age range. Twenty-one hospitals moved during the study period. OSHPD had reassigned the facility identifier for 11, and allowed the remaining hospitals to keep their original identifier. After reassigning the identifier, we had 457 GACH that could be followed over the entire study period or until closure. Our hospital-level analysis to identify factors predicting the GACH decision to stop discharging children uses 457 as the number of cases.

CASE SELECTION

We searched the PDD to identify all California residents from 30 days to 13 years old living in ZIP codes (ZIPs) between 90000 and 96162 admitted to a GACH for any reason. Records lacking a valid date of birth, sex, ZIP, admission source, and discharge disposition were not examined.

Patient clinical characteristics are classified using the ICD-9-CM as to its principal and secondary diagnoses, the Diagnostic Related Group (DRG), and after 1990, E-codes that classify environmental events, circumstances, and conditions as to the cause of injury, poisoning, and other adverse effects. To concentrate on the impact of changes for the majority of children admitted to hospital, we sought admissions with low to medium risk conditions, including those that would be sensitive to access to primary care.

We began by excluding records from the base PDD file by DRG, using the following criteria. We excluded all ungroupable DRGS; those related to pregnancy, newborn, neonatal, or cancer (including AIDS/HIV); and psychiatric DRGs that were not injury-related. Then looked for rare or unusual DRGs within the age groups 30 days to 4 years and 5 to 13 years. Within these age categories, we excluded DRGs that appeared less often than an average of 20 times a year in the years in which the DRG was recorded in that age group.

Having excluded major categories based on frequency, we turned attention to DRG weights to remove residual high-risk cases. DRG weights represent average resources required to care for cases in a particular DRG based on average resources used to treat cases in all DRGS, and as such reflect increased risk.[98] OSHPD provided a file of historical DRG weights. We updated the weights, from the CMS website.[99] The weights had a range up to 15.4. We excluded all DRGs with a 2002 weight greater than or equal to 4.8, the 99%ile of remaining DRG weights. Finally, we excluded any DRGs with fewer than 200 cases over all years. The purpose of these DRG exclusions was to enable us to focus on "typical" pediatric admissions without "noise" from unusual or high-risk cases.

At the end of the selection process, we had 2,841,536 records for California children age 0 to 13 at admission who were discharged from GACH between 1983 and 2000. Clinically, these children were in 242 of an original list of 503 DRGs. Of the 242 DRGs, 79 accounted for 90% of selected discharges, and 115 accounted for 95%.

GEOGRAPHIC DATA

Methods for handling geographic data are described elsewhere.[96] [100] We divided Los Angeles County, with about one-third of all discharges, into 8 Service Provider Areas (SPA), using information from the LA County Department of Public Health. We treat these as counties, increasing the number from 58 to 65. When data are summarized to the county level, this creates 1,170 county years of data for 1983 to 2000 (18 years times 65 "counties" = 1,170 county years). We combined geographic data from Census CD Tiger Line and SAS Institute county boundary files to create map boundary and annotation datasets for the California counties. In maps, we show LA county as one entity.

STRUCTURAL CHANGE INDICATORS

We examined two major classes of structural change indicators. The first focused on changes in administrative structure: ownership, consolidations, conversions, and moves. The second focused on structural capacity: 24-hour availability of services and beds. We calculated these measures on a calendar year basis at the hospital, county, HSA, and state levels.

ADMINISTRATIVE STRUCTURE

Change of Ownership (CHOW). Change of ownership (CHOW) occurs when hospital ownership control changes from one entity (typically a corporation or governmental agency) to another entity. In the hospital-level analysis, we indicate simply whether the hospital ever had any CHOW.

Conversions. Conversions occur when organizational type changes, for example, from nonprofit to investor, from public to nonprofit. In the hospital-level analysis, the hospital is flagged if there had ever been a conversion.

Organizational Type. We collapsed the AHDR 11-category Type of Control into three groups representing very different social purposes: public (university, district, city/county, state), nonprofit (including religious), and investor. We initially assigned religious hospitals to a separate category. After preliminary analyses, we concluded they were best treated as nonprofits. In the hospital-level analysis, we used organizational type on the last AHDR report.

Consolidated Reporting. By this administrative action, OSHPD permits data from two or more facilities with separate licenses to be submitted under the license of one facility for the AHDR or the PDD or both. In consolidated reporting, the hospital to submit the data is designated as the parent. The other(s) are designated as the subsidiary. Consolidated reporting makes it impossible to track what is going on at both the hospital and patient levels.

Hospital Moves. In the hospital-level analysis, we flagged hospitals that had moved as of the date of their last report. One hospital moved from one county to another. We counted this as a closure in the first county and as a new hospital in the second county.

AVAILABILITY OF SERVICES

Presence of a Hospital. A most fundamental issue is whether a given community has a hospital. All communities with no hospital in a given year were assigned the value of 0 on all structural characteristics.

24-hour Availability. The AHDR contains information indicating if the hospital had 24-hour availability of emergency services (emergency room (ER), trauma license), diagnostic capacity (physician, radiology, laboratory) and treatment capacity (surgeon, operating room, pharmacy).

Bed Availability. In this analysis, we focus on the availability of the following bed types: total daily service (TDS), medical-surgical acute care (MSA), non-pediatric intensive care (ICU), pediatric acute care (PAC), and pediatric intensive care (PIC).

Physician Availability. Similarly, the AHDR contains information as to the numbers of physicians with practice privileges by specialty and location. We used information as to whether any non-hospital (community-based) family practice, pediatricians, or pediatric specialty physicians had privileges at the hospital.

In the hospital-level analysis, these variables were a simple yes/no as to whether these capacities were available at the last report. At the county-level, these reflected counts of hospitals in a county with such a capacity. Some county-level variables were further summarized into whether the county had any such capacity, i.e., any public hospital.

POPULATION SOURCES

We used population estimates from the California Department of Finance (DOF) Demographic Research Unit to calculate HSA- and county-level rates per 10,000 population (the population rate).[101] Population estimates are subject to revisions, which may also modify age-, sex- and race-specific population distribution for all years in the series. The population estimates were published before the 2000 census adjustments.

To calculate annual population within LA County SPAs, we summarized ZIP populations in the 1990 census normalized to the 2000 census boundaries within SPAs,[102] then interpolated the data to get total annual population. We did not estimate race/ethnic or age sub-group populations, only total populations age 0 to 13.

Depending on analytic needs, data were summarized to the state or county by year and by various other categories within years. We used the number of hospital admissions from the patient's county of residence as the denominator to calculate rates per 100 discharges (the discharge rate) and the DOF population data to calculate rates per 10,000 children (the population rate).

INDICATORS FOR RESOURCES PER POPULATION

At each level (county, state) we calculated rates by dividing the number of resources (beds, 24-hour capacity) by the number of children and multiplying by 10,000 (rate per 10,000). We ranked resource indicators into quartiles over all the years and levels, which we then reversed so higher quartiles reflected shortages. We used these quartiles in some multivariate modeling and in mapping. For the ER, MSA, and PAC resource indicators, we created dummy variables with the value 1 if a given geographic level had a value below the median. We summed these to create a Resource Shortage Score with possible values of 0 to 3. Few regions were short in all 3 resources, mainly counties with no hospitals, so we collapsed this into categories 0, 1, or 2 or more shortages.

HEALTHCARE SYSTEM QUALITY INDICATORS

These indicators differ from the preceding in that they use combinations of discharge and population data. We summarized our measures to the various geographic levels and calculated rates per 10,000 population and per 100 discharges (%). Again, we ranked these summary variables over all years to better understand their quartile distributions. We used the summary measures in models at all levels (individual, county, state).

ACCESS INDICATORS

Admissions. We focus on total admissions and ambulatory care sensitive (ACS) admissions as delineated first by Billings and more recently by Backus and colleagues.[103] [104] ACS includes diagnoses such as bronchitis, pneumonia, respiratory infections, and other diagnoses for which access to primary care can prevent hospitalization.[105]

Out-of-County Care. We conducted a literature search to identify studies that included out-of-county (OOC) or out-of-region care as a measure of healthcare system quality. We found studies documenting regional variations in OOC based on healthcare infrastructure or access to healthcare, but none that explicitly tied OOC variations to patient outcomes. As we have conceptualized this measure, it is a simple yes or no answer to the question, "Is the county where the child lives the same as the county where the child is treated?" If the answer is no, then care was provided OOC. Our sense is that it is developmentally more appropriate for sick children to receive care near their home and families, but that a combination of the child's condition and/or the healthcare structure in the county of residence makes it impossible to obtain care locally.

Insurance Status. We consider insurance status as an access indicator because of the significant literature showing relationships between availability and type of insurance, and the decision to seek hospital care or to be admitted if care is sought. However, it also may reflect community-level economic factors, in that communities with high rates of poor child admissions likely have more poverty.

Given the lack of information on income or other SES measure we used payor as a proxy for poverty. Although some children from high-income families may be in the uninsured group, the overall percentage is very low given that 3.8% were uninsured at discharge in 2000, and we feel comfortable that primarily low income children are in this category. While some low income families are privately insured, with public insurance expansions extending eligibility to increasing numbers of low income children, and many employers cutting dependent benefits to low wage workers, we believe most low income children are now either publicly insured or remain uninsured. We may be more correct in this assumption in the later years of our study than in the early years.

The PDD variable describing insurance status changed several times between 1983 and 2000, as MC took hold. We are not able to assess the impact of MC longitudinally, since MediCal MC was not available on the PDD until 1999. In this paper, we focus on differences between public (MediCal, uninsured) and private (FFS, HMO/PPO, other employment-related) payors for health services.

Admission Source. The PDD contains a variable indicating the source of admission. In this analysis, we focus on ER admissions and transfers from another healthcare setting, contrasted with "routine" admission. We consider ER admissions an access issue in the sense that community-based services may not have been available to the child. We consider transfer from another healthcare setting as an indicator in that the child may not have had access to the appropriate type of care -- either community- or hospital-based -- when the medical condition first required care.

OUTCOME INDICATORS

Care Quality Indicators. We combined measures of adverse events sensitive to care (care quality indicators (CQI)), using software from other researchers. In this analysis, we do not distinguish types of events, but only whether one or more was found using any definition. Further, we use these as a measure to evaluate healthcare system performance, rather than to evaluate the care hospitals provided.

- **Adverse events by definition**. As an early attempt to measure adverse outcomes, the ICD-9-CM included a series of diagnosis and procedure codes that reflect adverse outcomes independent of their position in the array of diagnoses or procedures.

- **AHRQ Quality Indicators.** A more recent initiative is the development of the Agency for Health Research and Quality (AHRQ) software for quality indicators. This evaluates by events by clinical condition that are indicators of poor quality care.[106 107 108] Most events are for the adult population, but we did use those defined for children.

- **Outcomes Potentially Sensitive to Nursing (OPSN).** Needleman very generously provided the software his group developed to classify cases into OPSN.[68]

Extended Length of Stay. Many researchers have investigated ELOS as an adverse outcome. We did a series of analyses to examine whether stays longer than 4, 5, or 7 days reflected an adverse outcome for the pediatric population. Based on these analyses, we define a stay of longer than five days as an extended stay for this study.

Non-routine Disposition. Rather than attempting to measure patient outcomes in terms of specific procedures relative to specific medical conditions, we use the fact of a non-routine discharge disposition (NRD) as a provisional indictor of overall patient discharge quality.[50] This reflects the fact that the child did not exit the hospital to return home, but transferred to another organized healthcare environment or died. Because death occurred in less than 0.04% of our carefully selected cases, fortunately too infrequently to examine separately, we include it with NRD.

LINKING HOSPITAL AND PATIENT RECORDS

OSHPD distributes PDD files based on calendar years, with all cases in a given file discharged in that year. Some cases will have been admitted in a previous year, and some cases admitted at the end of a given year will not be available for analysis until the next year's data are released. A longitudinal study can smooth yearly lags. In this case, we selected admissions after 01 Jan 1983 and are missing a small number of admissions at the end of 2000. To estimate the impact, 1,331 (0.87%) children discharged in 2000 were admitted before that year.

OSHPD distributes AHDR files based on fiscal years. If a hospital's last fiscal year ended 31 October 2000, we are missing 3 months of AHDR data. In such a case, we carried forward to the end of 2000 the last available AHDR data. If a hospital closed, reopened, or changed ownership, it could have two or more AHDR reports in a calendar year.

To integrate the AHDR and PDD, we made an AHDR file containing the structural variables of interest for each report period. Next, we implemented a series of decision rules that resulted in one record per calendar year per hospital.[96] We made a "skinny" PDD file with key variables, and formats of AHDR data, that we used to merge with the skinny PDD file. Next, we implemented decision rules that needed information from both sources. Finally, we returned to the main PDD file to put hospital and county healthcare system characteristics onto PDD records for multivariate individual-level modeling. This last file with over 2.8 million records combines individual, hospital, and county data.

ANALYSIS METHODS

All work was done using SAS Release 8.2. Univariate analyses used PROC FREQ, MEANS, UNIVARIATE, and RANK. Multivariate modeling used PROC REG, GLM, MIXED, and LOGISTIC.[109 110] Maps were created using PROC GMAP, and plots used PROC GPLOT. We output results into Excel files for preparation of tables and graphics.

To understand the relative influence of child and healthcare system characteristics on the OOC decision, we developed propensity scores.[111 112] This involved a series of individual-level logistic regressions using the full 2.8 million records, incorporating healthcare system variables. We used parameter estimates to calculate the sum of the products of the estimates times the covariate values, first for the child characteristics yielding a child propensity score, and then for the county characteristics yielding a county propensity score. We then calculated quintiles for these two scores. Finally, we executed a general linear model with predicted OOC by county and child propensity score quintile, year, and their interactions.

Most work used macros we developed that incorporate the above PROCS and save results for subsequent processing. For example, we have a series of macros using PROC REG to carry out, accumulate, summarize, and store regression results, which we used to test the significance of state-level longitudinal trends and temporal associations.[113 114] An important macro developed for this study incorporates the ColorBrewer RGB spreadsheet to automate selection of graphic color schemes for maps and charts, which Cynthia Brewer generously provided.[115]

RESULTS

STRUCTURAL CHANGES

Table 2 summarizes hospital structure changes over the study period. In 1983, the number of GACH discharging children was 430. By 2000, despite an additional 27 hospitals opening during the intervening years, only 339 discharged children, a net loss of 91 hospitals (21%).

Table 2. Changes in Hospital Structure, 1983 and 2000

	Number		Change		% with	
Structure	1983	2000	N	%	1983	2000
Hospitals	430	339	(91)	(21)	100	100
Beds - Any						
Intensive Care	394	336	(58)	(15)	92	99
Pediatric Acute	223	155	(68)	(30)	52	46
Pediatric Intensive	28	37	9	32	7	11
Auspices						
Non-Profit	222	207	(15)	(7)	52	61
Public	89	54	(35)	(39)	21	16
Profit	119	78	(41)	(34)	28	23
24-Hour Availability						
Emergency room	414	327	(87)	(21)	96	96
Trauma care	6	47	41	683	1	14
Physician	323	278	(45)	(14)	75	82
Laboratory	272	266	(6)	(2)	63	78
Radiology	236	251	15	6	55	74
Operating room	145	177	32	22	34	52
Pharmacist	121	158	37	31	28	47
Anesthesiologist	105	166	61	58	24	49
Non-Hospital Based Physicians						
Family Practice	387	270	(117)	(30)	90	80
Pediatrician	347	259	(88)	(25)	81	76
Pediatric Specialty	50	94	44	88	12	28

This table explicitly distinguishes the presence of any of a bed type rather than specialty units. GACH must have beds designated for certain types of patients (including children) needing specialized 24-hour medical care.[116] For example, pediatrics is defined as a basic service for which a hospital must have appropriately staffed and equipped beds. However, designation for a PAC unit requires 8 or more PAC beds with special requirements as to population,[117] nursing service staff ratios,[118] staffing (pediatricians, registered nurses),[119] and other resources which must be available for a unit but which are not required with fewer pediatric beds.

In this context, although there had been a net loss of 58 hospitals with ICU beds, all but 3 surviving hospitals had at least one. Of hospitals discharging children, 223 reported at least one PAC bed in 1983, and 155 in 2000, for a net loss of 68 hospitals reporting even one PAC bed (30%). About half the hospitals that ever discharged children never reported even one PAC bed. By 2000, only 37 hospitals statewide had any PIC beds.

There was a 39% drop in public and a 34% drop in investor hospitals compared to a 7% loss of nonprofit hospitals. By 2000, nonprofits owned 61% of surviving hospitals. There was a net loss in 24-hour emergency and diagnostic services, 87 fewer (21%) hospitals had ER coverage, 45 fewer (14%) had 24-hour physician coverage, and 6 fewer (2%) had 24-hour laboratories. On the other hand, the percent of surviving hospitals with 24-hour treatment capacity (operating rooms, pharmacists, and anesthesiologists) increased by 22%, 37% and 61% respectively.

The number of hospitals with even one community-based primary care physician with admitting privileges also decreased. By 2000, 30% fewer hospitals had any family practitioners and 25% fewer had any pediatricians with privileges. About 20% of surviving hospitals had no community-based family practice physician, and 24% had no pediatrician despite licensing requirements for such a specialist to monitor pediatric admissions.[119]

THE INFLUENCE OF STRUCTURE ON CONTINUING TO DISCHARGE CHILDREN

Table 3 examines the likelihood of hospitals continuing to discharge children in 2000 (N = 457 hospitals). In most cases, hospitals no longer served children because they had closed. Some remained open but, as far as we could track, no longer admitted children.

Table 3. Likelihood of Hospitals Discharging Children in 2000

			Hospitals (N)			Hospitals (%)			CMH Statistics				
Class	Indicator	Category	Total	No Dis	Dis	Tot	No Dis	Dis	OR	LCI	UCI	Chi-Sq	Prob.
Administrative	Ownership	No change	222	59	163	49	27	73					
Structure		Change	235	61	174	51	26	74	1.0	0.7	1.6	0.02	0.8806
	Organization type	No change	384	103	281	84	27	73					
		Change	73	17	56	16	23	77	1.2	0.7	2.2	0.40	0.5297
	Last organization type	NP/PU	318	59	259	70	19	81					
		Investor	139	61	78	30	44	56	0.3	0.2	0.5	31.98	<.0001
	Consolidated Report	No	419	117	302	92	28	72					
		Parent	38	3	35	8	8	92	4.5	1.1	15.0	7.02	0.0073
		Subsidiary	38	32	6	8	84	16	0.05	0.02	0.12	71.73	<.0001
	Move	No move	436	116	320	95	27	73					
		Move	21	4	17	5	19	81	1.5	0.5	4.7	0.59	0.4425
Structural	Pediatric Acute Care	No	299	111	188	65	37	63					
Capacity		Yes	156	7	149	34	4	96	12.6	5.7	27.8	56.72	<.0001
	Emergency Room	No	57	31	26	12	54	46					
		Yes	398	87	311	87	22	78	4.3	2.4	7.6	27.40	<.0001
	Trauma Services	No	403	115	288	88	29	71					
		Yes	52	3	49	11	6	94	6.5	2.0	21.3	12.40	0.0004
	Physician	No	110	45	65	24	41	59					
		Yes	345	73	272	75	21	79	2.6	1.6	4.1	16.90	<.0001
	Laboratory	No	132	55	77	29	42	58					
		Yes	323	63	260	71	20	80	2.9	1.9	4.6	23.91	<.0001
	Radiologist	No	160	67	93	35	42	58					
		Yes	295	51	244	65	17	83	3.4	2.2	5.3	32.58	<.0001
	Operating Room	No	254	90	164	56	35	65					
		Yes	201	28	173	44	14	86	3.4	2.1	5.5	26.95	<.0001
	Pharmacist	No	273	92	181	60	34	66					
		Yes	182	26	156	40	14	86	3.0	1.9	5.0	21.38	<.0001
	Anesthesiologist	No	271	95	176	59	35	65					
		Yes	184	23	161	40	13	88	3.8	2.3	6.2	28.96	<.0001

In bivariate analyses, changes in ownership, conversions, and physical location did not affect a hospital continuing to discharge children, while investor ownership significantly decreased the likelihood. For hospital pairs using consolidated reporting, the parent ultimately closed 84% of subsidiaries. Of 14 subsidiaries with PAC beds, only 5 remained open according to sources we searched. The number of parent hospitals that discharged children increased by 5, suggesting consolidation rather than elimination of children's services. We do not know the physical location of these beds, i.e., closure in the subsidiary and open in the parent, or still in subsidiary.

Having PAC beds, an ER and trauma services increased the likelihood of continuing to discharge children. Maintaining or increasing 24-hour capacity in terms of staffing, diagnostic and surgical services also increased this likelihood.

Table 4 shows statistically significant variables from a stepwise logistic regression to predict whether hospitals would be discharging children in 2000. In this model, consolidations, moves, and investor ownership decreased the likelihood of continuing to treat children, while a change in ownership without conversion increased the likelihood of maintaining pediatric services. Having designated PAC beds, 24-hour ER and radiology services increased the likelihood of continuing to discharge children.

Table 4. Prediction of Hospitals Discharging Children in 2000

Variable	Est	Std. Error	Wald Chi-Sq	Wald Chi-Sq P	Odds Ratio Est	Odds Ratio LCI	Odds Ratio UCI
Intercept	-0.16	0.36	0.18	0.6682			
Consolidation Subsidiary	-4.12	0.64	41.83	<.0001	0.02	0.01	0.06
Hospital moved	-1.87	0.48	15.10	0.0001	0.2	0.1	0.4
Type of Control (Investor)	-1.33	0.32	17.27	<.0001	0.3	0.1	0.5
Change in Owner (Any)	0.79	0.30	6.82	0.009	2.2	1.2	4.0
PAC License	1.94	0.39	25.03	<.0001	6.9	3.2	14.8
24-Hr Emergency Room	1.00	0.36	7.76	0.0053	2.7	1.3	5.5
24-Hr Radiology	0.66	0.28	5.67	0.0172	1.9	1.1	3.3

C = 0.862, H-L Chi-Sq = 0.4403

IMPACT OF STRUCTURAL CHANGES AT THE POPULATION LEVEL

Table 5 examines the impact of structural changes on beds and 24-hour capacity at the population level. The study period saw a 49% increase in the number of children in the California population. During the same period, the number of pediatric hospital admissions dropped 13%, and the discharge rate per 10,000 children decreased 42%.

Table 5. Population Impact of Structural Changes, 1983 and 2000

Measure	License Type	Year 1983	Year 2000	Change N	Change %
Population 0 to 13	Children	5,262,199	7,855,614	2,593,415	49
	Discharges	176,406	153,732	(22,674)	(13)
	Dis/10,000 Children	335	196	(140)	(42)
Number of Beds	Total Licensed	88,235	84,662	(3,573)	(4)
	Med-Surg Acute	55,524	41,086	(14,438)	(26)
	Intensive Care	6,120	6,678	558	9
	Pediatric Acute	4,448	3,693	(755)	(17)
	Pediatric Intensive	360	653	292	81
	Other Beds	21,783	32,553	10,770	49
Beds Per 10,000 Children	Total Licensed	168	161	(7)	(4)
	Med-Surg Acute	106	78	(27)	(26)
	Intensive Care	11.6	12.7	1.1	9.1
	Pediatric Acute	8.5	7.0	(1.4)	(17)
	Pediatric Intensive	0.7	1.2	0.6	81
	Other Beds	41	62	20	49
Children Per 24-hour Services	Emergency room	12,711	24,023	11,313	89
	Trauma care	362,700	167,141	(195,559)	(54)
	Physician	16,292	28,258	11,966	73
	Laboratory	19,346	29,532	10,186	53
	Radiology	22,297	31,297	9,000	40
	Pharmacist	43,489	49,719	6,230	14
	Operating Room	36,291	44,382	8,091	22
	Anesthesiologist	50,116	47,323	(2,793)	(6)

Despite the 21% decrease in hospitals, the number of total beds dropped only 4%. A significant shift occurred in bed type, including a 26% loss of MSA beds. By 2000, 68 fewer hospitals (30%) reported any PAC beds (from Table 2), for a net loss of 755 PAC beds (17%). PAC bed loss was specifically associated with loss of PAC units, with an average of 11 beds per hospital.

This reflects a loss of the very beds with nursing coverage and staffing requirements dedicated to the population through age 13. Losses in MSA and PAC beds were offset by a 49% increase in other specialty beds that children rarely occupy. Much of these shifts occurred under cover of consolidated reporting.

The combination of losing hospitals with PAC beds, PAC units, and the growing child population resulted in a decrease in PAC bed availability from 8.5 per 10,000 in 1983 to 7 per 10,000 statewide in 2000. Because ICU beds increased and PIC beds almost doubled, their bed ratio increased.

The number of children for whom each surviving ER is responsible increased 89% from 12,711 to 24,023 per 10,000. Ratios of children per 24-hour diagnostic capacity measures (physician, laboratory, radiology) also rose significantly. In contrast, the number of hospitals with 24-hour treatment capacity (operating rooms, pharmacy, anesthesiologist), which had the largest increases over the study period, showed the smallest increases in population to service ratios.

DESCRIPTION OF CHILD CHARACTERISTICS AND OUTCOMES

Table 6 summarizes characteristics of children admitted in 1983 and 2000. Children age 0 to 4 accounted for most admissions and their numbers were relatively stable. The race/ethnic composition changed dramatically between 1983 and 2000 over the period. White non-Hispanic children represented 63% of 1983 admissions but only 39% of 2000 admissions, while the percent of Hispanic children doubled from 22% to 45% of admissions.

Table 6. Characteristics of Children Admitted to Hospital, 1983 and 2000

		Year		% Total		% Change	
Variable	Category	1983	2000	1983	2000	Absolute	Percent
Discharges	Total	176,406	153,732	100	100		
Age	0 to 4	104,392	96,794	59	63	4	6
	5 to 9 years	40,805	33,113	23	22	(2)	(7)
	10 to 13 years	31,209	23,825	18	15	(2)	(12)
Race/Ethnicity	White Non-Hispanic	110,592	59,956	63	39	(24)	(38)
	Hispanic All Race	39,610	69,087	22	45	22	100
	Black	18,597	15,752	11	10	(0)	(3)
	Asian	7,312	8,516	4	6	1	34
Access	ACS	78,827	65,373	45	43	(2)	(5)
	Injury	27,991	19,063	16	12	(3)	(22)
	Medical	39,886	46,893	23	31	8	35
	Surgical	29,702	22,403	17	15	(2)	(13)
	Private Payor	112,005	77,298	63	50	(13)	(21)
	Public Payor	64,401	76,434	37	50	13	36
	Out-of-County	44,486	46,224	25	30	5	19
	Routine	110,752	68,204	63	44	(18)	(29)
	Emergency Room	58,410	78,435	33	51	18	54
	Transfer	7,244	7,093	4	5	1	12
Outcomes	Adverse Event	16,702	23,509	9	15	6	62
	Extended LOS	35,437	24,435	20	16	(4)	(21)
	Non-Routine Discharge	3,876	6,364	2	4	2	88

Although the number of ACS admissions decreased, the percent of ACS cases remained steady at between 42 and 45% over the period. Injury and surgery cases decreased, both numerically and as a percent of cases. Medical cases increased numerically and as a percent of admissions. When looking at trends in rates per 10,000 population, the largest decrease occurred in ACS conditions and the smallest in medical conditions. These trends were significant for all conditions (P<0.0001). The steepest decreases occurred in all trends before 1994, after which rates increased or stabilized.

In 1983, private payors covered two-thirds of admissions. By 2000, responsibility was split evenly between public and private payors. Private admissions per 10,000 population were lowest in 1996 and increased after that. Public payor admissions decreased slightly until 1988, and peaked in 1996. There was a one to one trade-off in the percent of private payor cases in favor of public payor cases. The population admission rate for public payors equaled that of private payors in 1991 and from 1998 forward.

OOC admissions increased from 25% to 30% between 1983 and 2000. Between 1983 and 2000, routine admissions dropped from 63% to 44%, while those admitted through the ER increased from 31% to 51%, with a significant change in the trend after 1994. Transfers increased from 4% to 8% by 1994, then dropped sharply back to 5% in 1995. The effect was almost a one to one shift between ER and transfer percentages. Similar patterns were observed in the rates per population.

The risk of going OOC was not independent of admission source, payor, or time. Table 7 compares the relative risk of going OOC for each admission source and payor, using 1983 OOC as the reference.

Table 7. Relative Risk of Out-of-County by Admission Source and Payor, 1983 and 2000

		% OOC		%			
Source	Payor	1983	2000	Chg	RR	LCI	UCI
		26	30		1.24	1.21	1.26
Routine		27	33	6	1.31	1.28	1.34
ER		20	26	6	1.39	1.35	1.43
Transfer		38	53	15	1.87	1.75	2.00
Routine	Private	28	34	5	1.27	1.24	1.31
	Public	25	32	7	1.44	1.39	1.49
ER	Private	19	24	5	1.33	1.28	1.38
	Public	20	27	6	1.41	1.36	1.47
Transfer	Private	39	55	17	1.98	1.81	2.17
	Public	37	51	14	1.76	1.60	1.94

Children admitted OOC were less likely to be admitted through the ER in 1983 (20%) and 2000 (26%) as compared with routine admission or transfer. Between 1983 and 2000, the risk of going OOC for routine admissions increased 31%; ER, 39%; and transfers, 87%. In both years, private payor OOC children were more likely to be admitted routinely or transferred than public payor OOC children. The risk increase was greater for public payor children admitted routinely or through the ER. The OOC risk for private payor children almost doubled while that for public payor children increased by 76%, and differences between the groups were not significant at either time or over time.

The percent of discharges with adverse care quality indicators (CQI) rose steadily through 1990, and then remained relatively steady. ELOS rose through 1990 and decreased steadily thereafter. NRD rose through 1990, and was relatively steady thereafter. When CQI and NRD were expressed as rates per population, trends were basically flat because of increasing cases. That is, even though population-based risk for hospital admission decreased, population-based risk for adverse outcomes remained relatively steady despite population increases.

DISTRIBUTION OF STRUCTURAL, ACCESS AND OUTCOME MEASURES

Table 8 summarizes weighted mean distributions by quartile for key structural, access, and outcome measures (N = 1,170 county years), with each measure except PAC beds divided approximately into 293 county years per quartile. For PAC beds, the range was from an average of 10 beds per 10,000 children (Q0) to none (Q3 = 0). Higher quartiles reflect greater shortages or system burdens.

Table 8. Distribution of Key Measures Per 10,000 Population by Quartile

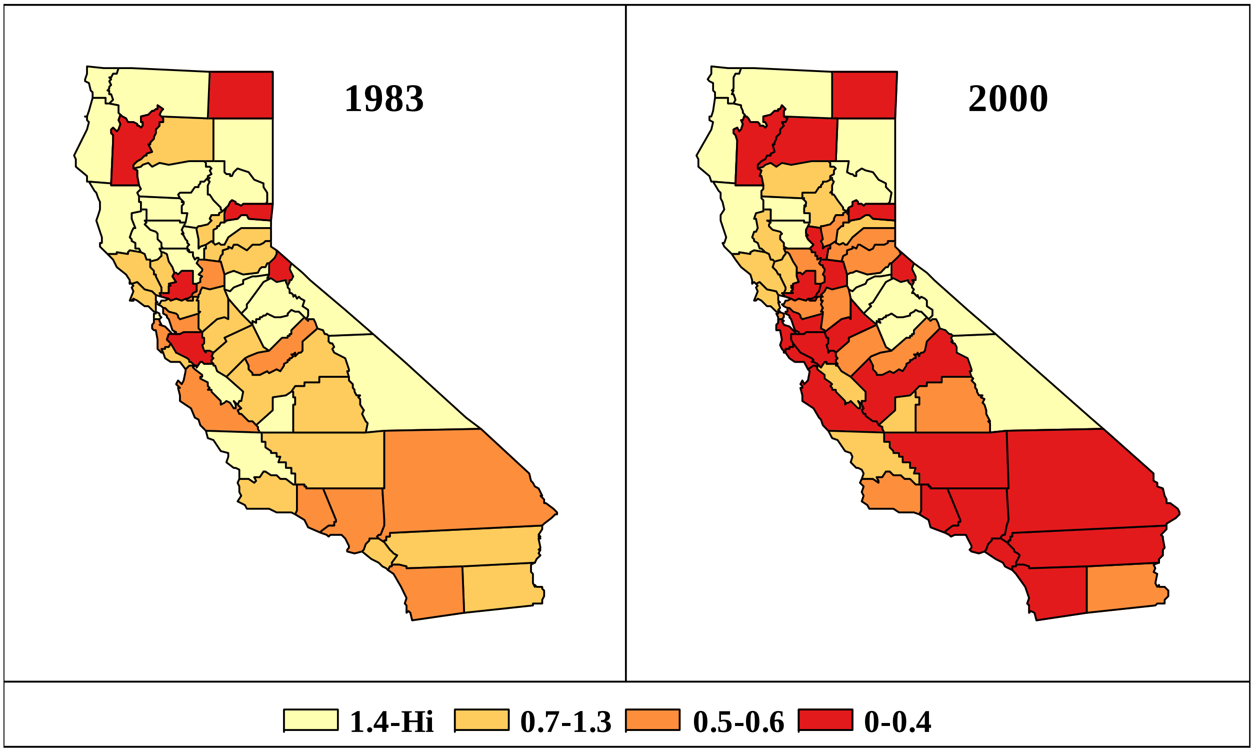
Measure	Indicator	Overall Mean	Quartile Mean Q0	Q1	Q2	Q3	Q3/Q0 Ratio
Structure	Total beds	137	245	134	99	63	0.3
	Medical-surgical beds	75	145	76	55	37	0.3
	Pediatric beds	6	10	5	3	0	0.0
	Emergency room	0.6	2.2	0.9	0.6	0.4	0.2
Access	Discharges	243	160	201	248	317	2.0
	ACS	105	60	79	107	145	2.4
	Public Pay	118	61	90	126	180	3.0
	Private Pay	125	74	95	123	182	2.5
	Out-of-County	67	20	59	90	177	8.7
	Emergency Room	103	62	83	103	143	2.3
	Transfer	14	7	10	14	26	3.9
Outcomes	Care Quality	34	20	26	34	48	2.4
	Stay gt 5 days	48	25	36	47	69	2.7
	Non-routine	9	5	8	10	13	2.4

The last column shows the ratio between Q3 and Q0. For all measures, there were significant differences between the two columns. The most extreme population disparities occur for the availability of PAC beds and OOC admissions.

EMERGENCY ROOM AVAILABILITY

Figure 2 maps compare counties by quartile for the number of children per ER in 1983 and 2000. The quartile with the highest ratio (pale yellow) has about 1.4 ERs per 10,000 children. The quartile with the lowest ratio (darkest red) has 0 to about 0.4 ERs per 10,000 population, more than a 4-fold difference and reflecting the greatest structural shortage. In 1983, 340,570 (6%) of California's 5.2 million child population lived in counties with the lowest ER ratio. In 2000, over 6.6 of 7.2 million children (90%) lived in counties with the lowest ER ratios. In fact, in 2000, the number of children in the lowest quartile counties was 25% more than the entire 1983 population. In 2000, four counties had no hospitals and thus no ERs.

Figure 2. Emergency Rooms per 10,000 Population, 1983 and 2000



IMPACT OF MULTIPLE SHORTAGES

Figure 3 illustrates the distribution of counties with no, one, or two or more population-based structural shortages (ER, MSA beds, PAC beds) in 1983 and 2000. In 1983, only 7 counties with a population of 85,223 children had 2 or more shortages. In 2000, 2.9 million children (37%) lived in areas with 2 or more core structural shortages, and only 9 counties had none.

Figure 3. Shortages in Core Structural Capacity, 1983 and 2000

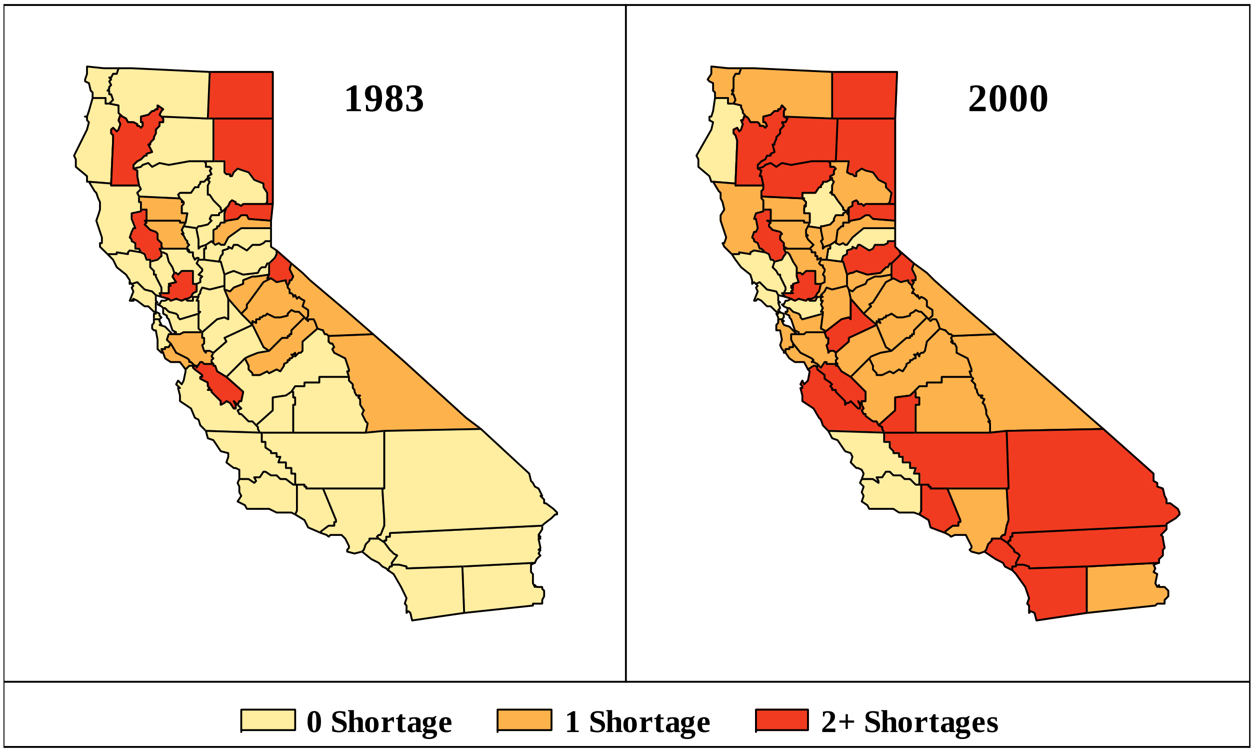


Table 9 summarizes relationships between core shortages and our analysis variables (N = 1,170 county years). Numbers under the Core Shortages columns are the least square means in models of the indicator predicted by shortages and year. The interaction term was nonsignificant in all models. The column headed ratio indicates, for example, that areas with 2 or more shortages had about 20% more discharges per 10,000 population than areas with no shortage. Living in a county with less structural capacity negatively impacted all access and outcome measures. The impact was similar when expressed as a percent of discharges.

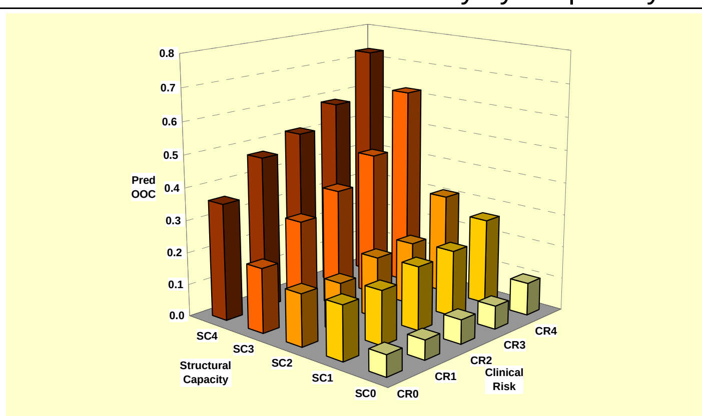
Table 9. Relationship of Core Shortages with Key Analysis Variables per 10,000 Population

		Core Shortages			Ratio	F P-Val	
Measure	Indicator	None	One	Two +	2/None	SHORT	YEAR
Population	Average	244,108	304,211	280,394			
Access	Discharges	239	245	280	1.2	0.0000	0.0000
	ACS discharges	101	106	128	1.3	0.0000	0.0000
	Private Payor	131	129	122	0.9	0.0008	0.0000
	Public Payor	107	116	159	1.5	0.0000	0.0000
	Out-of-County	52	63	131	2.5	0.0000	0.0000
	Emergency Room	100	99	124	1.2	0.0000	0.0280
	Transfer	13	15	15	1.1	0.0031	0.0000
Outcomes	Care Quality Indicator	32	34	42	1.3	0.0000	0.0000
	Extended LOS	46	48	62	1.3	0.0000	0.0000
	Non-routine disposition	8	9	10	1.2	0.0000	0.0000

RELATIONSHIP BETWEEN CHILD CHARACTERISTICS AND STRUCTURAL CAPACITY

We did a series of logistic (N = 2.8 million) and hierarchical models to quantify the influence of individual characteristics (age, race/ethnicity, payor, clinical class and DRG weight) and county-level structural characteristics (ownership type, any PAC or PIC beds, 24 hour physicians, operating rooms and pharmacies) on the probability of an individual child going OOC for medical care. We used the results to create propensity score quintiles.[112] Least squares predicted OOC means for county versus child quintiles are in Figure 4. A score of 0 reflects lowest clinical risk (CR0) and more adequate structural capacity (SC0).

Figure 4. Predicted Percent Out-of-County by Propensity Score Quintile



The percent of children predicted to be admitted OOC depended far more on the structural capacity of the residence county than on child characteristics. When children lived in a county with an adequate structural capacity (SC0), 6% to 10% were predicted to go OOC regardless of risk characteristics. On the other hand, for children with the lowest risk (CR0) the percent predicted to go OOC increased as the structural capacity declined in the county of residence. Although only 10% of children with the greatest risk living in a county with no structural shortages (CR4-SC0) were predicted to go OOC, 73% of children with the same characteristics were predicted to go OOC if they lived in a county with the worst capacity (CR4-SC4).

Children living in counties with at least one public hospital had significantly lower OOC risk than did children living in counties with none. In our county-year model to predict OOC the coefficient for having at least one public hospital was -0.41 when contrasted with nonprofit or investor hospitals. In the individual-level model, the coefficient for having a public hospital in the child's county of residence was -0.37.

IMPACT OF OUT-OF-COUNTY CARE ON SUBSEQUENT OUTCOMES

Similar to the interaction of OOC with access measures, OOC also interacted with the adverse outcome measures. Table 10 shows the relative risk of an adverse outcome given OOC care.

Table 10. Relative Risk of an Adverse Outcome Given Out-of-County Decision

	OOC (%)		Relative Risk		
	No Event	Event	RR	LCI	UCI
QCI	13.9	14.4	1.04	1.03	1.05
ELOS5	18.0	24.9	1.51	1.51	1.52
No QCI	16.7	22.6	1.45	1.44	1.46
QCI	25.7	38.8	1.83	1.80	1.86
NRD	3.5	3.9	1.12	1.10	1.35
No QCI	3.1	3.2	1.04	1.02	1.05
QCI	6.1	8.1	1.37	1.33	1.40

In this table, the first column shows the percent of children who did not go OOC and had an adverse outcome, and the second column shows the percent who went OOC and had an adverse outcome. Adverse outcomes were more common for OOC children in every combination. For example, OOC children were 4% more likely to experience a CQI (RR = 1.04) and 51% more likely to have an ELOS. Children with both ELOS and a CQI were 83% more likely to enter the hospital from OOC. NRD were 12% higher for OOC children. Those with both NRD and a CQI were 37% more likely to have come from OOC. Because of the numbers involved, all results are significant at P <0.0001.

DISCUSSION

Between 1983 and 2000 California experienced a net loss of key elements of hospital infrastructure affecting children. In 2000, 4 counties had no hospitals, 54% of surviving hospitals discharging children reported no licensed PAC beds, PAC beds decreased despite the rising pediatric population, and most PAC bed losses occurred among hospitals with licensed PAC units having more stringent requirements. There were 21% fewer GACH with ERs, 30% fewer with PAC beds, 14% fewer with 24 hour MD coverage, 26% fewer with community-based family practitioners, and 25% fewer with pediatricians. The loss of community-based family practitioners and pediatricians with hospital privileges is of concern, since these physicians form the first defense against admitting children for ACS conditions that were the bulk of admissions for the otherwise well children we studied.

The likelihood that hospitals would stop discharging children, which for most meant closure and for some bed conversions, was associated with consolidations and investor ownership. With an overall bed loss of 4%, there was a disproportionate loss of both MSA (25%) and PAC (12.5%) beds. These were replaced with other specialty beds that children rarely occupy.

In examining the impact of California's infrastructure changes, we included both indicators of access to care and in-hospital quality of care. Population-based discharge rates for all clinical groups decreased, with the largest decreases in ACS rates, although ACS conditions continued to account for about half of total discharges. Most of the ACS decrease occurred between 1983 and 1994 during a period of expanding government-funded coverage for lower income children. After 1994, the ACS rate rose and leveled off. Changes in ACS rates are consistent with improved access to care during initial insurance expansions with a reverse in direction as conflicting policies were implemented.

Payor can be expected to affect access to care in that lower reimbursement and more administrative regulations associated with public funding resulted in fewer physicians and hospitals accepting patients with this type of coverage.[22] In 1983, two thirds of hospitalized children were covered by private insurance. By 2000, 50% were covered by public insurance. In 1983, PPO/HMO plans were a small percent of private payors. By 2000, FFS had virtually disappeared (4%) and most private payor discharges were HMO/PHP. The transition to managed care exacerbated the situation, as payment declined even further while physician reporting requirements increased. MediCal's health plan capitation rates have been the lowest of any Medicaid program in the country for some time.[22 120] With the number of children covered by public insurance rising, the number of physicians willing to care for poor children decreased significantly due to extremely low reimbursement. Today half of California physicians refuse to serve MediCal patients, while nationally only 15% of physicians refuse to serve such patients.[22] In 1990, 12.9% of rural hospitals accepted Medicaid patients, compared to 17.3% in 2000. Rural hospitals admitting more Medicaid patients were more likely to remain open, while urban hospitals accepting more Medicaid patients were more likely to close.[33 34]

Today, advantages to the insurance industry of simultaneous eligibility expansions paired with payment and service contractions are clear. The rate of growth in premiums for a family of four exceeds that of the early 1990s, and employee contributions rose 70% in the last four years.[121] Profits of California insurers are among the highest in the nation.[122 123] California MediCal MC plans are financially stable and "outperform" both California health plans that do not serve MediCal beneficiaries and other Medicaid and non-Medicaid plans nationwide.[124] This profitability is expected to continue despite California's current fiscal crisis.[125] These benefits to the insurance industry occurred without reduction in the percent of uninsured children, which remained remarkably steady at about 15%.[16 17 18 19]

Characteristics of place or source of admission can be access indicators. In this study we examined OOC admissions, admissions through the ER, and transfers from another facility as indicators reflecting inadequate access to primary care and inadequate hospitals including no hospitals. Between 1983 and 1994, percentages of children admitted OOC increased from 26% to 30%; ER admissions from 33% to 51%, and transfers doubled from 4% to 8%. For both OOC and ER admissions these trends were steady after 1994. However, the percent of transferred children decreased sharply in 1995 and remained level thereafter. This could reflect reluctance by hospitals in managed care networks to transfer patients to facilities that would require them to pay out of plan costs.

Although the relative risk of entering from OOC increased for all admission sources, the magnitude of the increased risk ranged from 31% for routine admissions, 39% for ER admissions, and 87% for transfers. Relative risks by admission source differed by payor with public payor children having a greater OOC risk. Differences among payor sources reflect different options for the publicly and privately insured. Today many counties have no public hospitals and surviving hospitals may limit admissions of patients with public or no insurance. These findings make sense. Decreases in the number of hospitals, those with ER capacity and child-oriented physicians, and decreases in MSA and PAC beds equally affect rich and poor. These findings support a hypothesis that structural capacity loss was associated with poorer access in-county, and particularly, appropriate pediatric services in the community and hospital.

An extended literature search found only one study that explicitly examined long-term consequences of hospital closures on patient care.[126] Its findings are similar to ours. That study described longitudinal changes in numbers of hospital admissions and ER visits after 2 of 9 hospitals with ERs closed as part of a cost containment effort in Stockholm, Sweden. These closures resulted in a 10% net loss of beds. The government hoped that this would shift care to primary care clinics. Over a 3-year period after the closures, acute admissions dropped only 0.2% while ER visits increased 21%. The percent of patients arriving at the ER without previous medical contact increased from 78% to 84%, and transfers from other hospitals increased 3%. By the end of the study, waiting times to see an ER physician were significantly longer, particularly for younger, not-referred patients. LOS increased in the ER, due partly to increased caseloads and diagnostic bottlenecks for resources such as x-ray equipment. The number of younger patients without referral increased. They were less likely to be admitted, suggesting primary care access problems. The authors concluded that the expected shift to integrated primary care did not occur. Community-based providers resisted the shift of responsibility and hospitals were used as primary care centers. As in California, there were no financial incentives for change, since both hospitals and primary care providers were subject to budget cuts.

Outcome indicator trends also showed significant increases over time. Most troubling in this regard is that we carefully picked the lowest risk children. By definition, they were expected to have fewer adverse outcomes and would not receive advanced procedures that might increase complication risk. In what would be expected as cost containment and DRG-based reimbursement was implemented, the percent of ELOS discharges increased until 1990, then dropped steadily through 2000 as payment mechanisms took hold. On the other hand, CQI and NRD increased steadily until 1990 and remained relatively stable thereafter. With increasing population and a stable number of admissions, one would expect a drop in the population-based rate of in-hospital adverse events. On the contrary, population rates remained stable and in-hospital rates increased. This suggests that changes in care quality for the lowest risk children suffered because of changing structural capacity, and that increased adverse outcomes cannot be attributed to advanced technology for this population.

Structural changes and associated changes in access and outcomes were not equally distributed, with increasing prevalence of wide geographic disparities for all study variables. Figure 2 maps clearly demonstrate a significant increase in counties with the most children served per ER. The percent of California children living in counties with the lowest ER coverage ratios went from 6% to 91%. Figure 3 maps illustrate changes in cumulative structural shortages. In multivariate models, the number of core structural shortages is strongly linear with less desirable values for all access and outcome indicators. This is powerful evidence that significant geographic disparities exist in access to and quality of care, that many children are needlessly hospitalized as a consequence of these disparities, and that outcomes are strongly associated with these structural disparities.

To further understand inter-county differences we used propensity scores to predict OOC. Our propensity model confirmed that county structural characteristics were the primary factor in OOC hospitalization. Although only 10% of children with the highest risk in a low-risk population were predicted to go OOC in a county with no structural shortages, 73% with the same level of risk were predicted to go OOC if they lived in a county with the worst capacity.

It is important to note that having at least one public hospital in a county significantly decreased OOC risk in both county- and individual-level models. This was true regardless of the insurance status of the individual child. Having a public hospital in a county protects all children.

Thus, we established that an increasing proportion of hospital admissions are OOC and that increasing OOC rates are associated with increasing structural shortages. To determine the impact of OOC on outcomes, we calculated the relative risk of adverse outcomes on those who went OOC compared to those who did not. Going OOC increased the risk of all our adverse outcomes and increased the risk of suffering multiple adverse outcomes.

This can be the result of several factors. Children going OOC were more likely to come from counties without hospitals or lacking pediatric physicians, making it difficult to obtain community-based primary care. Such scenarios suggest a longer period between when a child first has symptoms and when that child accesses care. This could cause ordinarily low risk children to be sicker when they reach the hospital and thus more susceptible to adverse outcomes regardless of the quality of in-hospital care. We showed that many children going OOC live in areas with less adequate infrastructure including poor ER coverage. This also would mean longer travel and probably longer waits for care once they reach the hospital, further exacerbating the situation. Children in counties without a public hospital, or indeed no hospital (3 in 1983 and 4 from 1997 forward), can expect further barriers to care, particularly if they are poor.

Changes in structure, access, and outcomes were temporally associated with an explicit abandonment of a state-mandated formal regional health planning process in favor of "voluntary" planning while other states maintained this type of system. Our findings suggest that this policy failure had significant negative consequences on adequacy of the healthcare infrastructure to serve children. Coupled with its population explosion, California fell further behind relative to other states in terms of structural capacity. The lack of community-based physicians, hospitals and ERs, and increased distances and time to obtain care apparently took their toll, making sick children sicker by the time they were admitted and more vulnerable to adverse events, thereby doubly disadvantaging them.

Unlike what happened in other states, a friendly regulatory environment enabled hospitals to avoid health planning mechanisms. With no oversight from planners, hospitals closed or moved, ownership conversions and consolidations were permitted, and beds were closed or converted, in areas with the greatest population increases. These changes could be expected to affect timely access to services that allow children to receive outpatient care and thereby avoid more severe illnesses or complications. It is particularly relevant to consider the magnitude of these changes in light of California’s dismal showing for most of the capacity indicators monitored by the federal government. As shown in Table 1. California today ranks at the bottom relative to other states for most of these indicators.

POLICY CONCLUSIONS AND RECOMMENDATIONS

In the 1970s, the California legislature established a policy of mandated health planning. Until 1987, California operated under a regulatory system with a formal planning structure and coordinated regional health planning similar to that of many other states. Then, under pressure from the hospital lobby, the legislature reversed this policy, relying on voluntary cooperation to honor the intent of the planning process.[27] Other states maintained formal planning policies, and now rank much higher than California on Federal health infrastructure indicators.[48] Our findings strongly suggest that the abandonment of state planning resulted in a progressive deterioration of California's infrastructure that adversely affected children's access to care and hospital outcomes. Increasing geographic disparities in structural capacity affect both publicly and privately insured children, with poor children at greater risk.

For the last decade, advocates and researchers focused on the effects of increasing access to insurance or what happens in the hospital. Our study shows that other concomitant policy decisions greatly compromised the healthcare infrastructure, and the resulting disparities impact both access and outcome indicators. These findings provide solid evidence that "voluntary" planning failed California's children. In this vein, we think similar issues likely need to be examined for the adult population, as adults generally are admitted to the same hospitals.

Allowing the market to plan health services did not control rising costs, did not result in equitable infrastructure distribution, did not decrease the percent of uninsured children, caused large numbers of children to be needlessly admitted to hospital, and increased their exposure to adverse outcomes. Administrative decisions such as changes in ownership, consolidations, conversions, and moves sacrificed infrastructure that could provide access to hospital and primary care. These activities diverted huge sums of public and private monies to the insurance and hospital industries, with their associated consultants, lawyers, and off-shore corporations,[41] [42] [43] [44] [45] [46] at the expense of population health and the healthcare needs of communities.

In 1979, Churchman wrote: "…simple, direct, head-on attempts to 'solve' systems problems don't work and, indeed, often turn out to be downright dangerous. (p. 3-4)"[127] A quarter-century later, California's children daily experience the consequences of our turn away from rational, data-driven health planning toward a free market approach. In the hope of better health care for children, we make the following recommendations.

RECOMMENDATION 1: Reinstitute Regional Planning. Our findings should provide the impetus for a legislative initiative to re-establish mandated regional health planning. OSHPD is the appropriate agency to assume this responsibility, since its vision statement is: "Equitable Healthcare Accessibility for California."[128] OSHPD was responsible for health planning in the past, maintains data systems that could be used to monitor results of policy changes, and currently authorizes quality of care studies.

We envision a careful legislative study of existing provisions in the Health and Safety Code that established HSA, HFPA, and Certificates of Need, updated to reflect current standards, to assure adequate and equitable access to primary and hospital care across all regions of California. These changes should be accompanied by an ongoing monitoring system to assess the adequacy of the health care infrastructure and to monitor indicators of healthcare access and quality for children and for adults, with an eye to disparities.

RECOMMENDATION 2: Improve Data Quality. To make real the term "audited," we recommend legislation (funded via increases in hospital licensing fees) to develop rigorous methods to validate information in hospital-level datasets and implement strategies to maintain high quality data. Others have identified data quality deficiencies in the AHDR, including ownership, bed capacity, and utilization (days, discharges).[129] [130] [96] We do not have the same quality concerns about the PDD data that we have about the AHDR and related hospital-level data, as OSHPD has conducted a number of reabstraction studies with excellent results.[131 132]

At the least, we recommend reconciling discharges and days reported in the various hospital-level datasets to those actually found in the PDD. As part of the bi-annual CALS survey, Licensing and Certification could reconcile numbers of beds reported to those found in the hospitals. Staffing hours should be reconciled with actual staffing data collected as part of payroll activities. Similarly, we recommend reconciling financial numbers reported in tax returns, bond applications, and annual financial statements with those submitted to OSHPD. Hospitals found to systematically under- or over-report should be fined.

RECOMMENDATION 3: Dismantle consolidated reporting. Consolidated reporting completely obscures how many hospitals are open and where they are physically located. One high-level OSHPD official we interviewed said the state had no idea how many hospitals or emergency rooms or beds actually existed in California or where they were physically located and called the situation a "disaster waiting to happen." The use of different numbers for the same facilities for different purposes should be discontinued. One uniform facility number should be instituted across all departments, with sub-numbering to specify the exact geographic location of the unit, including latitude and longitude. The number should be assigned to the physical location and should not change with ownership or type of care provided. This number should be in all datasets to make it easy to merge different information for a given analysis.

Improving data quality and simplifying the reporting impact of consolidations would make it possible for future researchers to more easily answer address fundamental infrastructure issues: Are hospitals are open? Where they are physically located? Are they licensed to care for the population they are discharging?

Only by interviewing people and engaging colleagues across the state and nation were we able to get information that would lead us to know where to look to be able to even begin to understand what was happening. The overall problem seems to be one of transparency, the fact that it is so difficult to clarify and resolve (to the extent we were able) the data problems we encountered. Opaqueness benefits hospitals and thwarts legitimate public policy needs.

RECOMMENDATION 4: Enforce Existing Regulations. We strongly recommend that existing provisions of the Health and Safety Code be enforced, particularly with respect to requirements that pediatricians or board-eligible pediatricians supervise care of children in hospitals. Similarly, provisions need to be strengthened and enforced requiring pediatric registered nurses to care for pediatric patients no matter the licensing status of the unit. Licensing and Certification should pay particular attention to where in a hospital the pediatric population stays, who cares for them, and whether pediatric standards are followed.

RECOMMENDATION 5: Strengthen Nurse Staffing, Training, and Reporting. If children are to continue to be treated in MSA rather than PAC units, we urge strengthening MSA nursing staff training and certification requirements to address the specific needs of the pediatric population they apparently are treating with some frequency. Hospitals should be required to report children discharged from ICU and MSA beds to enable the health services community to better monitor units where pediatric care is provided.

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[117] Title 22, Social Security. Division 5. Licensing and Certification of Health Facilities, Home Health Agencies, Clinics, and Referral Agencies, Chapter 1. General Acute Care Hospitals, §70537. Pediatric Service General Requirements. (d) Patients beyond the age of 13 shall not be admitted to or cared for in spaces approved for pediatric beds unless approved by the pediatrician in unusual circumstances and the reason documented in the patient's medical record.

[118] Title 22, Social Security. Division 5. Licensing and Certification of Health Facilities, Home Health Agencies, Clinics, and Referral Agencies, Chapter 1. General Acute Care Hospitals, §70217. Nursing Service Staff. (6) The licensed nurse-to-patient ratio in a pediatric service unit shall be 1:4 or fewer at all times.

[119] §70539. Pediatric Service Staff. (a) A physician shall have overall responsibility for the pediatric service. This physician shall be certified or eligible for certification by the American Board of Pediatrics. If such a pediatrician is not available, a physician with training and experience in pediatrics may administer the service. In this circumstance, a pediatrician, qualified as above, shall provide consultation at a frequency which will assure high quality service. (b) A registered nurse who has had training and experience in pediatric nursing shall be responsible for the nursing care and nursing management in the pediatric service. (c) In addition to the above, there shall be a registered nurse present on each shift with responsibility for patient care. (d) There shall be sufficient other staff to provide adequate care. (e) There shall be evidence of continuing education and training for the nursing staff in pediatric nursing.

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