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# Measuring the Output of Health in the United States

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## Introduction

The health sector is one of the largest sectors of the U.S. economy. In 2004, the U.S. economy produced $1.855 trillion in health-related goods and services, accounting for 15.8 percent of U.S. gross domestic product.[1] A sector of this size must be accurately measured and appropriately understood if national economic accounts are to be credible.

BEA is currently exploring many avenues of research in health accounting. I describe two avenues being explored by BEA in this paper: the construction of a satellite account for health-related home and volunteer production, and the calculation of direct volume indexes for health care services. Continued work in health accounting will improve the quality of the national accounts and deepen understanding of a crucial sector of the U.S. economy.

## Accounting for Home and Volunteer Production

The construction of an account for home and volunteer production of health care services has become substantially more possible in recent years as a result of two innovations. The first is the publication of *Beyond the Market* (National Research Council, 2005), a report by the National Research Council that offers a useful set of recommendations from a blue-ribbon panel of economists for producing such an account. The second is the American Time Use Survey (ATUS), a joint project of the Bureau of Labor Statistics (BLS) and the Bureau of the Census (henceforth referred to simply as Census). The ATUS surveys adult Americans about time usage; in 2004, it surveyed 14,000 people. It includes weights that can be used to estimate the number of hours spent by all Americans age 15 and older on specific activities over the entire year.

Following the recommendations of *Beyond the Market* and using data from the ATUS and other sources, I constructed a concise account for home and volunteer production of health-related services in the United States in 2004. The account is presented in Table 1. It values the output of the home and volunteer health sector at $313.1 billion. When this sum is added to the $1.855 trillion estimate of market output in the health sector in the NIPAs, the combined market, home, and volunteer output of the health sector is $2.168 trillion. Of this combined total, 86 percent is market production and 14 percent is home and volunteer production.

In this account, home and volunteer health sector output is measured from the income side. This is done by estimating the "shadow" payments that would have been necessary to employ the factors used to produce home and volunteer health-related services. I measure shadow payments to two factors: labor and capital. The volume of labor is measured with the ATUS, and the price of labor—the shadow wage—is measured with summary data from the Occupational Employment Statistics (OES) survey, which is conducted by BLS, and with data from the Current Population Survey (CPS), another joint project of BLS and Census. Shadow payments to capital are measured using data from BEA's Fixed Assets tables.

Measuring the labor component of health-related home and volunteer production involves two steps: measuring the amount of time spent on health-related activities, and valuing the time so that it can be measured in monetary terms. Using the ATUS, I measure the number of hours spent by adults in 2004 on six types of activities: health-related care for self; health-related care for others; participation in sports, exercise, and

[1] Author's calculations from National Income and Product Accounts, Tables 1.1.5, 2.4.5, 3.17, 5.4.5B, and 5.5.5.

recreation; public health volunteer activities; travel related to medical services; and travel related to participation in sports, exercise, and recreation. Time spent in all six of these activities are assumed to make some contribution to health-related home and volunteer production.

Health-related care for self includes time spent on health-related self care, on personal care emergencies, and on using and waiting for medical care services. According to the ATUS, adults in the United States spent 11.7 billion hours on these activities in 2004. Since it is generally not possible to hire another person to do these activities, this time should be valued at the opportunity cost of one's own time. This can be measured as the post-tax wage that one earns or would earn in market work. I imputed this wage (henceforth "own wage") for each person in the ATUS using the average post-tax wage of people of the same sex, age, and education in the March 2005 CPS.[2] At own wages, total time spent on health-related care for self is valued at $158.1 billion.

Health-related care for others includes activities related to household and non-household children's health, providing medical care to and obtaining medical care services for household and non-household adults, and waiting associated with caring for household and non-household adults. A total of 2.91 billion hours were spent on these activities by adults in 2004. Since it is possible to hire others to do these activities, this time can be valued at a market rate. According to OES summary statistics, the hourly wage of home health aides was $9.13 in May 2004 and $9.23 in November 2004. I chose to average the two and assume that the cost of hiring someone else to care for others is $9.18 per hour. At this wage, the value of the 2.91 billion hours spent caring for others is 2.91 billion $\times$ $9.18 = $26.7 billion.

Participation in sports, exercise, and recreation covers time spent on a wide range of activities. It includes obviously healthy activities such as running and swimming as well as less physically taxing pursuits such as billiards and darts. Adults spent 24.5 billion hours on these activities in 2004. Since it is impossible to hire someone to run or swim for you, time spent on these activities must be valued at own wage. Using own wage values the time spent on sports, exercise, and recreation at $357.1 billion. Not all of this $357.1 billion, however, should count toward home production of health-related services because not all sports, exercise, and recreation are done for health-related purposes. People also participate in these activities for their own enjoyment, and some of the value of the time spent on these activities are given up in exchange for enjoyment rather than health. I assume that 20 percent of participation in sports, exercise, and recreation is health-related. Under this assumption, the contribution of time spent on sports, exercise, and recreation to a home health sector account is 20 percent of $357.1 billion, or $71.4 billion.

Public health volunteer activities include donating blood and providing medical services as a volunteer. Since it is possible to hire other people to do this, the 296 million

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[2] I measure the pre-tax wage in the CPS as personal earnings divided by hours worked, which is the product of weeks worked and hours worked per week. The post-tax wage is the pre-tax wage times one minus the marginal tax rate. There are seven age groups (15-17, 18-24, 25-34, 35-44, 45-54, 55-64, and 65+) and five education groups (no high school diploma, high school diploma, some college, four-year degree, and graduate degree); people in the 15-17 age group are not split into separate education groups, and people in the 18-24 age group with college degrees are not split between people with four-year and graduate degrees. The average wage is calculated as a weighted average across people by hours worked.

hours adult Americans spent on these activities were valued at the $9.18 hourly wage of home health aides, leading to a monetary value of $2.7 billion. Travel related to medical services is valued in the same way as health-related care for self, at own wage; this approach values the 1.6 billion hours spent on this activity at $22.8 billion. Finally, travel related to sports, recreation, and exercise is valued for the health accounts in the same way as participation in sports, recreation, and exercise: at own wage, times 0.20 to reflect the presumed share of time spent on these activities for the purpose of health. For health accounting purposes, this approach values the 3.1 billion hours spent on travel related to sports, exercise, and recreation at $9.3 billion. Summing the monetary values of time spent in the six kinds of health-related activities described above values the total labor component of home and volunteer health-related production at $291.0 billion.

The capital component of health-related home and volunteer production is the shadow rent on the stock of health-related durable goods owned by households. The only obviously health-related durable goods category in the NIPAs is ophthalmic products and orthopedic appliances. The shadow rent paid on this stock can be calculated as the product of the value of the stock itself and $(r + \delta)/(1 + r)$, where $r$ is the risk-free interest rate and $\delta$ is the depreciation rate of ophthalmic products and orthopedic appliances. BEA's Fixed Assets tables estimates the stock of ophthalmic products and orthopedic appliances at the end of 2003 at $63.9 billion and the depreciation rate at 27.5 percent. If we assume the risk-free interest rate is 2.5 percent, the rental value for 2004 of the yearend 2003 stock is (.30/1.025)63.9 = $18.7 billion. However, this is not the rental value of the complete stock available in 2004, as $22.9 billion in new production of ophthalmic products and orthopedic appliances was added to the durable goods stock in 2004. If we assume that this new production was added to the stock the midpoint of 2004, the rental value of new production for 2004 is .5(.30/1.025)22.9 = $3.4 billion. Adding up the rental values of previously existing stock and of new production yields a total rental value of $22.1 billion for ophthalmic products and orthopedic appliances for 2004; this is also the total capital component of health-related home and volunteer production. Adding the labor and capital components together yields a total value for health-related home and volunteer production of $313.1 billion.

The account presented in Table 1 suggests that the home and volunteer health sector is small and labor-intensive. It is less than one-fifth the size of the market health sector, and more than ninety percent of its shadow income is accounted for by labor. About half of it is accounted for by time spent providing health care to oneself and receiving medical services for oneself. Less than ten percent of it is accounted for by time spent providing care to others or volunteering for the purpose of public health.

Future work on the topic of household accounts will include expanding it to include more years. One straightforward expansion is the inclusion of all years for which the ATUS is available; currently, the ATUS is available for 2003, 2004, and 2005. Another possibility for future work is re-calculation of the health account under alternative assumptions, particularly about the value of time and about the contribution of various activities toward health-related home and volunteer production. For example, the labor component of home and volunteer production would be larger if time spent providing medical care to others was valued at the mean hourly wage across all health care support occupations—$11.17 in May and $11.30 in November 2004—rather than the lower wage of home health aides. Alternative calculations would help check the robustness of the initial estimates presented here.

**Direct Volume Measurement of Hospital Inpatient Services**

In the United States, the health sector is mostly private, and market prices are available for most health care services. Price deflation is therefore a feasible option for calculating the real output of health care services in the United States, and it is the approach used in the NIPAs. Even in the presence of prices, however, direct volume measurement of health care services is a feasible and interesting alternative.

One component of health care services that lends itself very well to direct volume measurement is hospital inpatient services. The volume of hospital inpatient services is particularly easy to measure because of two data sets from which a time series of hospital discharges can be constructed: the National Hospital Discharge Survey (NHDS), which is produced yearly for the National Center for Health Statistics (NCHS) of the Centers for Disease Control (CDC), and the Nationwide Inpatient Sample (NIS), which is produced for the Health Care Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ). Both the NHDS and the NIS include data about hospital discharges and about the status of the discharge (alive, dead, to another hospital, etc.) The NIS also includes data about total charges for the hospital stay. Indexes for the volume of inpatient hospital services in the United States are presented in Figure 1.[3]

Volume indexes for 1993-2003 produced from NIS data are presented in the first panel of Figure 1. The bottom index is a simple count of discharges, normalized to 100 in 1993. The middle index is a Fisher index of discharges classified by Clinical Classifications Software (CCS) diagnosis. Discharges for each CCS diagnosis are weighted by mean charges for that diagnoses. The Fisher index, unlike the simple count index, is not based on the complete set of 259 CCS diagnoses; rather, it is an index of discharges for a subset of 245 diagnoses. The subset of 245 diagnoses account for 99.7 percent of discharges in 1993 and 99.9 percent of discharges in 2003. The 14 CCS diagnoses that are not included in the Fisher index are excluded because of incomplete data on discharges or mean charges in the summary NIS data tables that are published by AHRQ.[4]

The top index in the first panel of Figure 1 is a Fisher index of discharges that has been adjusted for changes in survival rates for a subset of 175 CCS diagnoses. The survival rate is defined as the percentage of discharged patients who are alive at the time of discharge. The 175 CCS diagnoses are the set of diagnoses for which complete time-series data on survival rates are published in AHRQ's NIS summary data tables for 1993-2003. The other 70 CCS diagnoses, for which published survival data are incomplete, are still included in the Fisher index, but there is no survival adjustment for them.[5]

The survival rate adjustment borrows heavily from Dawson, Gravelle, O'Mahony *et al* (2005). The adjustment is relatively simple: when using a Fisher index to calculate changes in volume between periods $t$ and $t+1$, replace the volume of discharges for

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[3] The indexes presented in Figure 1, in particular the Fisher indexes, are similar to those for government hospitals in Christian *et al* (2006).

[4] These data are available at the HCUP web site at http://hcup.ahrq.gov/. The 14 excluded CCS diagnoses are listed in section III of Appendix A.

[5] The 175 CCS diagnoses for which the survival adjustment is made are listed in section I of Appendix A; the 70 diagnoses for which the survival adjustment is not made are listed in section II of Appendix A.

diagnosis $i$ in period $t$+1, $q_{it+1}$, with the adjusted volume of discharges $(a_{it+1}/a_{it})q_{it+1}$. If $s_{it}$ and $s_{it+1}$, the survival rates for diagnosis $i$ in periods $t$ and $t$+1, are both greater than 0.85, the adjustment $a_{it+1}/a_{it}$ is set to $(s_{it+1} - 0.8)/(s_{it} - 0.8)$. This adjustment is based on the assumption that these diagnoses, if untreated, will reduce quality of life to 80 percent of its pre-disease state. If either $s_{it}$ or $s_{it+1}$ are less than 0.85, the adjustment $a_{it+1}/a_{it}$ is equal to $s_{it+1}/s_{it}$. These diagnoses presumably lead to death if untreated. If $i$ is one of the 70 CCS diagnoses for which survival data are incomplete, the adjustment $a_{it+1}/a_{it}$ is set to 1.

Comparison of the three indexes based on the NIS suggests that adjusting for the composition of hospital discharges by diagnosis—the effect of using a Fisher index rather than a simple count of discharges—has a small effect on growth in the volume of hospital inpatient services. The simple count of discharges grows at an annual rate of 1.1 percent over 1993-2003, while the Fisher index grows at an annual rate of 1.3 percent. On the other hand, the effect of adjusting for changes in survival rate is quite large; the annual growth rate of the survival-adjusted Fisher index is 2.1 percent.

A similar trio of indexes, produced from NHDS data, are presented in the second panel of Figure 1. The bottom index is a simple count of hospital discharges. The middle index is a Fisher index of hospital discharges by diagnosis, classified by Diagnoses Related Group (DRG). The number of discharges by DRG are from the NHDS data, but mean charges by DRG, which are used as weights in the Fisher index, are from summary NIS data published by AHRQ. The discharge volume data in the NHDS and the mean charges data in the NIS are probably not a perfect match; there are likely to be some differences between the coding of individual patients by DRG between the NHDS and the NIS.

Because the definitions of DRGs change over time, several DRGs were combined to create consistent time series of discharges and mean charges over time.[6] Mean charges were averaged across the combined DRGs using the number of discharges by DRG in the NIS as weights. The combinations yielded a time-consistent set of 505 DRGs. Because of a coding error in the DRG variable in the 1994 NHDS data set, the number of discharges by DRG in the 1994 data was imputed with the average of the number of discharges in 1993 and 1995.[7] Of the 505 combined, time-consistent DRGs, complete time series over 1993-2003 for number of discharges in the NHDS and mean charges in the NIS are available for 442 DRGs.[8] The Fisher indexes presented in the second panel of Figure 1 only includes discharges from this subset of 442 DRGs, which accounts for 96.9 percent of NHDS discharges in 1993 and 96.5 percent of NHDS discharges in 2003.

The top index in the second panel of Figure 1 is a Fisher index from the NHDS data for the same 442 DRGs with adjustments for changes in survival rates for all 442 DRGs. The survival rates were calculated from NHDS data; survival rates for 1994 were imputed using the mean of 1993 and 1995 survival rates. The mechanics of the survival adjustment are the same as the mechanics of the adjustment used for the Fisher index

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[6] These combinations are listed in Appendix B.

[7] The NHDS data used were downloaded from the Inter-University Consortium for Political and Social Research (ICPSR) web site at http://www.icpsr.umich.edu. The exception is the 1996 data, for which the NHDS data at ICPSR had the same DRG coding problem as the 1994 data; a version without the DRG coding problem, available at the Centers for Disease Control web site, was used instead.

[8] The 63 excluded DRGs are presented in Appendix C.

based on NIS data presented in the first panel of Figure 1, with the exception that the survival adjustment is made for all diagnoses rather than for a subset of diagnoses.

Comparison of the three NHDS-derived series in the second panel of Figure 1 is very similar to comparison of the three NIS-derived series in the first panel. The simple count of NHDS discharges grows at an annual rate of 1.2 percent, the unadjusted Fisher index grows at a rate of 1.6 percent, and the survival-adjusted Fisher index grows at a rate of 2.5 percent. As before, this suggests that adjusting for the composition of discharges has a small positive effect on the growth of a direct volume measure of inpatient hospital services. It also suggests that adjusting for patient survival rates has a larger positive effect.

The third panel of Figure 1 plots changes in the quality of inpatient hospital services that can be accounted for with changes in patient survival rates. The quality index is equal to the ratio of the survival-adjusted Fisher index and the unadjusted Fisher index, normalized to 100 in 1993. Because there are two pairs of Fisher indexes—one derived from NIS data and one derived from NHDS data—there are two series for inpatient hospital services quality. The two series are very closely correlated; the correlation coefficient between the two is .99 in levels and .87 in first differences. This suggests that the measured implicit changes in quality from survival rates are quite robust to the data. The two series suggest that, when only survival rates are taken into account, the quality of inpatient hospital services improved by a total of about 8 or 9 percent over the ten years between 1993 and 2003.

One of the most interesting aspects of the direct volume indexes presented above is their measurement of health care services by diagnosis rather than by procedure. This approach has several advantages. In particular, it interprets technological changes that allow particular diagnoses to be successfully treated with fewer procedures and with lower-cost procedures as reductions in the price of health care. However, the ability of the indexes above to capture price reductions of this kind is impaired by the limitation of the indexes to inpatient hospital services. The ideal diagnosis-based index would measure the volume or price of successful treatments for individual ailments across *all* health care goods and services: inpatient hospital services, outpatient hospital services, doctor's office visits, prescription drugs, etc. Such an index would interpret a much wider range of cost-saving technological improvements as price decreases; for example, technological changes that allow diagnoses that were formerly treated with expensive inpatient hospital stays to be treated with less expensive outpatient treatments as decreases in price. This is an obvious avenue for future work that is already being pursued by researchers at BEA; Aizcorbe and Nestoriak's (2006) work on episode-based health care pricing in particular bears mention.

**Conclusions**

The development of accounts for health-related home and volunteer production and the construction of direct volume indexes for health care services are only two of many possible avenues for research into health accounting. Other possible avenues include improved measurement of health care prices, alternative measures of changes in the quality of health care, and measurement of the stock of health itself. Research at BEA on the wide range of issues related to accounting for health will improve the accuracy and usefulness of the U.S. national accounts and enrich public understanding of the health sector in the U.S. economy.

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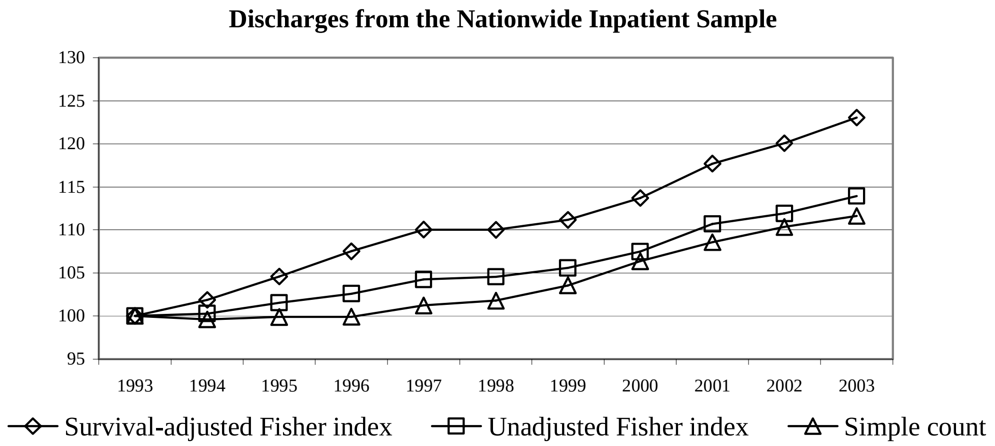
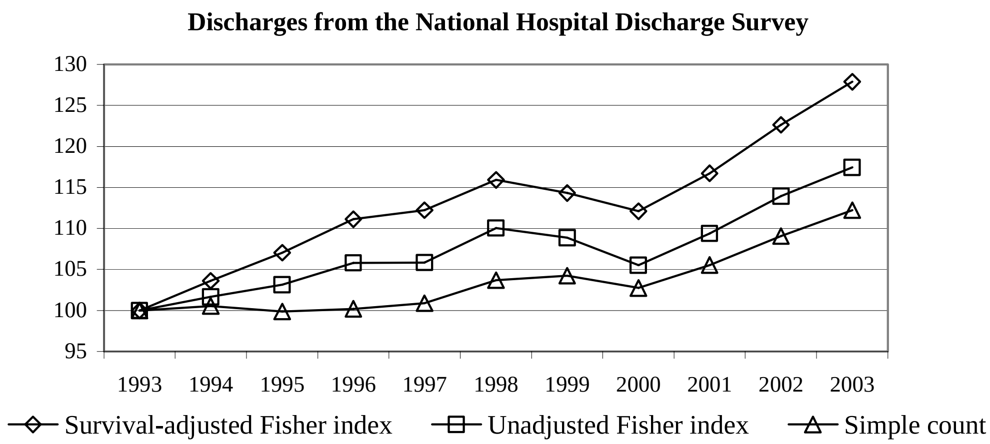
**Table 1. Market, home, and volunteer output in the U.S. health sector, 2004**

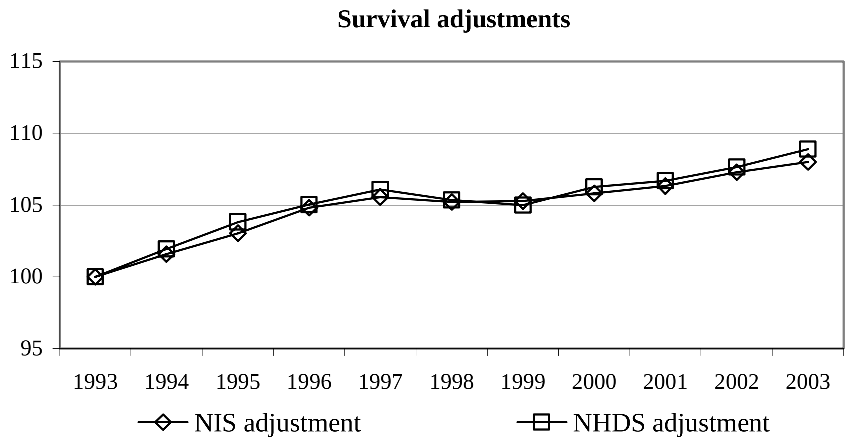
| | (billions) |
|---|---|
| NIPA health expenditures | $1,855.1 |
| Personal consumption expenditures | $1,677.3 |
| Medical care services, including insurance | $1,401.1 |
| Drug preparations and sundries | $253.3 |
| Ophthalmic products and orthopedic appliances | $22.9 |
| Gross private domestic investment | $82.4 |
| Hospitals, special care, and medical buildings | $30.0 |
| Medical equipment and instruments | $52.4 |
| Government consumption and gross investment | $95.4 |
| Nondefense health consumption expenditures | $77.6 |
| Nondefense health gross investment | $17.8 |
| | |
| Home and volunteer health production | $313.1 |
| Labor component | $291.0 |
| Health-related care for self (11.7 billion hours valued at own wage) | $158.1 |
| Health-related care for others (2.9 billion hours valued at $9.18/hour, the average wage of home health aides) | $26.7 |
| Sports, exercise, and recreation (24.5 billion hours times 0.2 health-related share valued at own wage) | $71.4 |
| Public health volunteer activities (296 million hours valued at $9.18/hour) | $2.7 |
| Travel related to medical services (1.6 billion hours valued at own wage) | $22.8 |
| Travel related to sports, exercise, and recreation (3.1 billion hours times 0.2 valued at own wage) | $9.3 |
| Capital component | $22.1 |
| Service flow from ophthalmic/orthopedic stock (One-year flow from $63.9 billion stock at yearend 2003 plus half-year flow from $22.9 billion new production in 2004, at 27.5% depreciation and 2.5% interest rates) | |
| | |
| Total market, home, and volunteer health production | $2,168.2 |

Data on market health expenditures are from author's calculations from Tables 1.1.5, 2.4.5, 3.17, 5.4.5B, and 5.5.5 of the NIPAs. Hours worked data are from the 2004 ATUS. Own-wages data are from the March 2005 CPS. The wage of home health aides is from Occupational Employment Statistics of the BLS. Data on the ophthalmic/orthopedic stock are from the Fixed Assets tables of the BEA.

## Figure 1. Direct volume indexes for hospital inpatient services



**Appendix A. CCS diagnosis codes for indexes based on NIS hospital discharges data**

I. 175 CCS diagnosis codes for which complete time-series data over 1993-2003 are available on number of discharges, mean charges, and survival rates.

1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 27, 29, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 47, 48, 50, 51, 52, 55, 58, 59, 60, 61, 62, 63, 64, 66, 67, 68, 69, 71, 76, 77, 78, 79, 81, 83, 85, 95, 96, 97, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 114, 115, 116, 117, 118, 120, 121, 122, 123, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 157, 158, 159, 160, 161, 162, 163, 164, 175, 181, 195, 197, 198, 199, 201, 202, 203, 204, 205, 207, 210, 211, 212, 213, 217, 218, 219, 220, 224, 225, 226, 227, 228, 229, 230, 231, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 248, 249, 250, 251, 252, 254, 259

II. 70 CCS diagnosis codes for which complete time-series data over 1993-2003 are available on number of discharges and mean charges, but data are incomplete on survival rates.

9, 22, 26, 28, 30, 31, 34, 46, 49, 54, 56, 70, 72, 74, 80, 82, 84, 89, 90, 91, 92, 93, 94, 98, 113, 119, 124, 136, 156, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 177, 178, 179, 180, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 196, 200, 206, 208, 209, 214, 215, 216, 221, 222, 232, 247, 253, 257

III. 14 CCS diagnoses for which time-series data over 1993-2003 on number of discharges or mean charges are incomplete.

10, 53, 57, 65, 73, 75, 86, 87, 88, 176, 223, 255, 256, 258

**Appendix B. Combined DRGs for NHDS volume indexes**

| DRG | Other DRGs combined with DRG at left |
|---|---|
| 1 | 2, 528, 529, 530 |
| 4 | 531, 532 |
| 5 | 533, 534 |
| 14 | 15, 524 |
| 104 | 514, 525, 535 |
| 105 | 515 |
| 112 | 116, 516, 517, 518, 526, 527 |
| 231 | 537, 538 |
| 302 | 512, 513 |
| 400 | 539, 540 |
| 434 | 521 |
| 435 | 523 |
| 436 | 437, 522 |
| 497 | 519 |
| 498 | 520 |

**Appendix C. 63 DRGs not included in Fisher indexes based on NHDS data**

36, 38, 39, 40, 41, 42, 61, 109, 136, 214, 215, 221, 222, 268, 275, 276, 317, 319, 327, 330, 342, 347, 351, 362, 375, 382, 411, 412, 419, 428, 432, 456, 457, 458, 459, 460, 463, 465, 467, 469, 470, 472, 480, 481, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511