Role of Transurethral Resection of the Prostate in Population-based Prostate Cancer Incidence Rates

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The extensive pool of asymptomatic prostate disease in the population, which increases substantially with age, suggests that the frequent use of transurethral resection of the prostate (TURP) in recent decades has had a large effect on prostate cancer incidence. The authors identified the effect of TURP-detected prostate cancer on the observed incidence rates between 1973 and 1993 for men aged 65 years and older. They linked population-based cancer registry data from the Surveillance, Epidemiology, and End Results Program to Medicare records between 1986 and 1993 to determine whether a TURP occurred sufficiently close to the time of a prostate cancer diagnosis for them to assume that it led to the diagnosis. TURP-detected cases prior to 1986 were calculated using an indirect method that involved multiplying the TURP procedure rate in the general population (from the National Hospital Discharge Survey) by estimates of the proportion of TURPs resulting in a prostate cancer diagnosis (from Medicare data and the literature). TURP explained much of the observed increase in overall prostate cancer incidence between 1973 and 1986 and possibly all of it in men aged 70 years and older. However, its influence on the trend and overall magnitude of the rates diminished between 1987 and 1993. The changing role of TURP in detecting prostate cancer is attributed to changes in medical technology and screening practices. The declining influence of TURP on prostate cancer incidence is likely to have continued beyond the study period due to the recent introduction and increasing use of medications for treating obstructive uropathy. Am J Epidemiol 1999;150:848–60.

Medicare; prostatectomy; prostate-specific antigen; prostatic neoplasms; SEER Program

Prostate cancer is the most frequently diagnosed cancer among men in the United States (1). The reported incidence of this disease increased between 1973 and 1992, most strikingly between 1989 and 1992 (2). Incidence peaked in 1992 and has since declined (3–8). The annual age-adjusted (standardized to the 1970 population) rates increased about 2 percent between 1973 and 1986, 6 percent between 1986 and 1989, and 20 percent between 1989 and 1992, and then decreased 13 percent between 1992 and 1994. These statistics reflect the most dramatic change in reported incidence witnessed for a given cancer site in a relatively short time interval. The extensive amount of asymptomatic prostate disease in the population suggests that changing patterns in the use of transurethral resection of the prostate (TURP) in recent decades to treat obstructive uropathy have made a substantial contribution to prostate cancer incidence rates and trends. Autopsy studies have identified a large pool of undiagnosed prostate disease in the population, which increases as a function of age beginning in the third decade of life (9–15). The extent of disease that would never be detected clinically (latent) or would eventually be detected clinically (preclinical) makes the reported incidence of prostate cancer particularly susceptible to the increased use of medical interventions, such as transurethral resection or detection by the prostate-specific antigen (PSA) test. The sharp increase in prostate cancer incidence rates between 1990 and 1992 is due, in part, to a shift in the time of diagnosis resulting from the rapid introduction of PSA testing (16, 17). For the period prior to the widespread use of PSA testing, population-based studies have suggested an association between the use of TURP and
prostate cancer incidence rates (18, 19). The high TURP procedure rates during this period further suggest that TURP-based detection of prostate cancer was common.

The purpose of this study is to determine the impact TURP has had on prostate cancer incidence before and during the period of PSA testing. A refined methodology and use of Medicare records linked to population-based cancer registry data will be used to validate the results of the earlier studies (18, 19) and extend these results to specific age groups and more recent years. Determining the influence of TURP on prostate cancer incidence rates provides a foundation on which we can then show the impact PSA testing has had on the rates since the late 1980s. It further provides an historical record of the incidence of prostatic hyperplasia in the population managed by TURP and the proportion of prostate cancer identified as a result.

The data used in this analysis include population-based cancer registry data linked to Medicare records from 1986 to 1993 to directly identify whether a TURP occurred close enough to the time of diagnosis that we could assume that it led to a prostate cancer diagnosis. For the years prior to 1986, when linked data were not available, we calculate TURP-detected prostate cancer by using an indirect method. This method involves multiplying the rate of TURP in the general population by estimates of the proportion of TURPs resulting in a prostate cancer diagnosis. These methods provide an important understanding of the effect TURPs have had on the identification of prostate disease in the United States.

**MATERIALS AND METHODS**

**Direct method: Identifying prostate cancer diagnosed by TURP using linked Medicare cases, 1986–1993**

*Data sources.* Prostate cancer case information was obtained from cancer registries in five states (Connecticut, Hawaii, Iowa, New Mexico, and Utah) and four metropolitan areas (Atlanta, Georgia; Detroit, Michigan; San Francisco-Oakland, California; and Seattle, Washington) between 1973 and 1993. These registries are participants in the Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute and represent approximately 10 percent of the US population. The SEER Program routinely collects and annually reports patient demographic information, tumor characteristics, and diagnostic and extent of disease information (20).

SEER data identify prostate cancer cases by the month and year of diagnosis. The SEER Program also collects information on cancer surgery, but these data are limited because only the most aggressive surgical procedure received by the patient is recorded. For example, if a man had a TURP and a radical prostatectomy, the hierarchical data set would record only the radical prostatectomy. On the other hand, the Medicare data provide detailed person-level information for all surgical procedures, including TURP, by day, month, and year. In general, Medicare data are available for about 93 percent of persons with cancer aged 65 years or older who have been reported to the SEER Program (21). Ninety-seven percent of persons aged 65 or more are eligible for Medicare.

Medicare records are collected by the Health Care Financing Administration and include demographic and enrollment information (Part A, Part B, and health maintenance organization (HMO) enrollment) for eligible persons. The Medicare data also contain all bills submitted for inpatient hospitalizations (Part A), outpatient hospital services (Part B), and services provided by physicians (Part B). Procedures are reported in the hospital inpatient data using *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM) codes (22), from the hospital outpatient data utilizing ICD-9-CM codes and *Current Procedural Terminology*, Fourth Edition (CPT-4) codes (23), and from the physician data using CPT-4 codes.

We used SEER registry data linked to Medicare claims data for the years available, 1986 through 1993, to determine TURP-detected prostate cancer incidence rates. SEER data linked with the Medicare claims data provide a unique database, described in detail elsewhere (21). Hereafter, we refer to these Medicare beneficiaries as linked Medicare cancer cases.

There were 94,957 prostate cancer patients identified by the SEER Program between 1986 and 1993 who were aged 65 years or older at the time of their diagnosis. Of these men, 88,388 (93 percent) were linked to Medicare. We excluded 6,562 (7 percent of the SEER Program total and 7 percent of Medicare cancer total) Medicare beneficiaries enrolled in an HMO because Medicare utilization data were not available for these patients. We also excluded 329 cases with unknown month of diagnosis. This left 81,497 cases for analysis.

*Determining whether a TURP procedure led to a prostate cancer diagnosis.* Since a TURP procedure could assume that it led to a prostate cancer diagnosis. This required that we make certain assumptions. If a man with prostate cancer had two or more
TURPs reported in the Medicare cancer data, we considered only the TURP closest to the diagnosed cancer. The TURP procedure also had to be performed within a “reasonably” close time of the diagnosis month. To account for possible inaccuracies in Medicare procedure billing dates (available by day, month, and year) and SEER Program diagnosis dates (available by month and year only), we defined a time window around the month of diagnosis in which we assumed that the TURP led to the detection of prostate cancer. We investigated the relation between the date of the TURP and the month of diagnosis (Table 1). Very few TURPs occurred until 7 days prior to the month of diagnosis, so we started our time window at this point. Many more TURPs occurred after diagnosis, presumably for relief of obstructive symptoms. It was impossible to distinguish which of these TURPs led to or followed a diagnosis, but ending the window 7 days after the month of diagnosis allowed for the same amount of date inaccuracies on both ends of the month of diagnosis. We will examine later, through sensitivity analysis, the impact of this choice on the results.

Prostate tissue is needed to confirm histologically whether prostate cancer cells are present. Hence, a needle biopsy, a TURP, or some other form of surgery (e.g., lymph node biopsy) is necessary for diagnosis. We assumed that if a man had a needle biopsy and a TURP during the window of diagnosis the TURP did not lead to the diagnosis, so we removed these men as TURP-detected cases. In the time window, of cases undergoing both a TURP and a needle biopsy, 51 percent of needle biopsies occurred before the TURP, 40 percent occurred on the same day as the TURP, and the remaining 9 percent occurred shortly after the TURP. Although some of the TURPs that occurred just before, on the same day as, or shortly after a needle biopsy may have led to the diagnosis, the uncertainty surrounding these TURPs and the possibility of incorrect billing dates led us to delete them. On the other hand, if a TURP was performed during the window, but no needle biopsy was performed, then we assumed that the TURP led to the finding of prostate cancer.

Medicare hospital inpatient, outpatient, and physician bills data were reviewed to determine whether a TURP and/or a needle biopsy was received. TURP procedures were identified from the notation of ICD-9-CM code 60.2 or CPT-4 codes 52601, 52612, 52614, 52620, 52630, or 52650. Needle biopsy procedures were identified by ICD-9-CM code 60.11 and CPT-4 codes 55700–55705. However, a single procedure can generate bills from more than one type of Medicare file, which could result in disagreement about the date of the procedure and also lead to double counting. To prevent this potential biasing effect, we considered duplicate procedures of the same type from different billing sources to be the same if their billing dates were within a 2-week period of each other for needle biopsies and within 6 weeks of each other for TURPs. The selection of these time windows was based on the recovery time for these procedures (e.g., it is highly unlikely that a man would receive a second TURP before having a chance to recover from the first). In instances of date disagreement, the date was taken from one file by using the most reliably recorded

**TABLE 1. Distribution of TURP** procedures relative to the month of prostate cancer diagnosis†, United States

<table>
<thead>
<tr>
<th>Time of TURP from month of diagnosis</th>
<th>Year of diagnosis</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>(n = 3,863)</td>
</tr>
<tr>
<td>TURP prior to diagnosis</td>
<td></td>
</tr>
<tr>
<td>%≥4 months before (n = 2,601)</td>
<td>0.26</td>
</tr>
<tr>
<td>%≥3 months before (n = 24)</td>
<td>0.08</td>
</tr>
<tr>
<td>%≥2 months before (n = 42)</td>
<td>0.23</td>
</tr>
<tr>
<td>%≥8–13 days before (n = 249)</td>
<td>0.85</td>
</tr>
<tr>
<td>%≥1–7 days before‡ (n = 621)</td>
<td>2.69</td>
</tr>
<tr>
<td>% TURP same month as diagnosis§ (n = 20,565)</td>
<td>78.93</td>
</tr>
<tr>
<td>TURP after diagnosis</td>
<td></td>
</tr>
<tr>
<td>% 1–7 days after (n = 672)</td>
<td>1.48</td>
</tr>
<tr>
<td>% 8–31 days after (n = 1,422)</td>
<td>3.08</td>
</tr>
<tr>
<td>% 2 months after (n = 711)</td>
<td>1.45</td>
</tr>
<tr>
<td>% 3 months after (n = 366)</td>
<td>0.52</td>
</tr>
<tr>
<td>%≥4 months after (n = 2,723)</td>
<td>10.43</td>
</tr>
</tbody>
</table>

* TURP, transurethral resection of the prostate.
† Data source: linked Medicare prostate cancer cases (see text for description).
‡ Time periods considered as windows of diagnosis.
The Medicare noncancer cases include a 5 percent sample of Medicare-eligible men who were not enrolled in previously defined, as well as data for men who did not have data for 1986-1993 from Medicare data. The Medicare NHDS to calculate population-based TURP rates for is available only for all races combined. We used the survey uses ICD-9-CM codes for diagnoses, biopsies, and surgical procedures. Age-specific information tal records, the NHDS provides a cross-sectional TURP procedure rates were obtained for the period 1973-1993 from the National Center for Health Statistics-conducted National Hospital Discharge Survey (NHDS) (figure 1) (24). From surveyed hospitals, the NHDS provides a cross-sectional weighted estimate of discharges in the United States. The survey uses ICD-9-CM codes for diagnoses, biopsies, and surgical procedures. Age-specific information is available only for all races combined. We used the NHDS to calculate population-based TURP rates for 1973–1993.

We also obtained population-based TURP procedure rates for 1986–1993 from Medicare data. The Medicare data include linked Medicare cancer cases, as previously defined, as well as data for men who did not have cancer, whom we refer to as Medicare noncancer cases. The Medicare noncancer cases include a 5 percent sample of Medicare-eligible men who were not enrolled in an HMO who resided in the SEER Program areas between 1986 and 1993 and did not have cancer. The sampled Medicare noncancer cases (weighted by 20) were combined with the linked Medicare cancer cases (weight of one) to create population-based annual rates of TURP for 1986–1993. The TURP rates derived from the Medicare data were almost identical between white men and black men, which led us to utilize combined rates. A comparison of the TURP procedure rate trends in the years of overlap from the NHDS and Medicare data shown in figure 1 suggest that TURP rates derived from the Medicare data were similar to those obtained from the NHDS. Therefore, we used NHDS TURP rates because they were available for a longer time period.

Deriving the proportion of TURPs leading to a diagnosis of prostate cancer. To compute the proportion of TURPs leading to a diagnosis of prostate cancer between 1986 and 1993, we divided the prostate cancer cases tagged as being detected by TURP by the population-based number of TURPs. From these combined data sources, the proportion of TURPs that led to a prostate cancer diagnosis was computed by age and year (figure 2).

For the period prior to 1986, we did not have data on the percent of TURPs that resulted in a prostate cancer diagnosis. The results of three studies conducted in the late 1970s (25, 26) and the 1980s (27) indicate that for the period 1978–1985 the proportions of TURPs that resulted in a prostate cancer diagnosis were similar to those estimated in the late 1980s using the Medicare data. Thus, we used the Medicare data from the combined period 1986–1990 as the estimated proportions between 1978 and 1985 (figure 2). Prior to 1978, the proportion of TURPs leading to a prostate cancer diagnosis may have been lower. A study by Newman et al. (25) of consecutive patients undergoing transurethral resection of clinically benign prostate glands at a single hospital derived the proportion of TURPs leading to diagnosed prostate cancer in two time periods, 1972–1973 (n = 500) and 1978–1979 (n = 500). For ages 60 years and older, the proportion was 57 percent lower in 1972–1973 compared with 1978–1979, 10.3 ± 3.1 percent versus 18 ± 3.8 percent, respectively. This change is explained, at least in part, by a change in medical practice during the 1970s, in which fewer prostate chips were routinely examined in the earlier period (25). To account for the lower prostate cancer-to-TURP ratio between 1973 and 1977, we assumed that the change in proportion observed for ages 60 years and older in the Newman study applied to each age group and adjusted the proportions derived from the 1986–1990 Medicare data down in equal increments until, for 1973, they reached 57 percent of the 1978 proportion.

Indirect method. Identifying prostate cancer diagnosed through TURP between 1973 and 1993

Because of the high occurrence of TURP procedures in the 1970s and 1980s (16, 17), evaluating TURP-detected prostate cancer incidence during these years is of primary interest. However, Medicare cancer data were available only for 1986 through 1993. Hence, a direct estimation of the influence of TURP procedures on prostate cancer incidence for the years prior to the SEER-Medicare linkage was not possible. Therefore, we applied an indirect method to estimate TURP-detected prostate cancer incidence.

Prostate cancer incidence rates detected by TURP can be expressed as the product of two factors: the TURP procedure rate multiplied by the proportion of TURPs leading to a prostate cancer diagnosis, that is,

\[
\frac{\text{TURP}}{\text{Population}} \times \frac{\text{Prostate Cancer}}{\text{TURP}} = \left[ \frac{\text{Prostate Cancer}}{\text{Population}} \right]_{\text{TURP}}
\]

Deriving TURP procedure rates. Population-based TURP procedure rates were obtained for the period 1973–1993 from the National Center for Health Statistics-conducted National Hospital Discharge Survey (NHDS) (figure 1) (24). From surveyed hospital records, the NHDS provides a cross-sectional weighted estimate of discharges in the United States. The survey uses ICD-9-CM codes for diagnoses, biopsies, and surgical procedures. Age-specific information is available only for all races combined. We used the NHDS to calculate population-based TURP rates for 1973–1993.

We also obtained population-based TURP procedure rates for 1986–1993 from Medicare data. The Medicare data include linked Medicare cancer cases, as previously defined, as well as data for men who did not have cancer, whom we refer to as Medicare noncancer cases. The Medicare noncancer cases include a 5 percent sample of Medicare-eligible men who were not enrolled in
Although only one study could be identified to report the change in the proportion of TURPs leading to a prostate cancer diagnosis during the 1970s for all ages combined and by age-specific groups (25), two additional studies (26, 27) reported very similar proportions for all ages combined to the proportion based on the second data set collected in the late 1970s in the first study (i.e., about 14 percent). This gives us more confidence in the age-specific proportions used in our analysis. We later explore the sensitivity of our results with respect to the estimated large change in the 1970s of the proportion of TURPs leading to diagnosed prostate cancer.

**Statistical analysis of prostate cancer trends**

Weighted least-squares regression coefficients were calculated to estimate and test the significance of the annual percent changes in total, TURP-, and non-TURP-detected prostate cancer incidence rates. The estimated
RESULTS

Trend analysis

Trends in total, TURP-, and non-TURP-detected, age-adjusted prostate cancer incidence rates are presented (figure 3). The two lines with plus symbols will be discussed later under the sensitivity analysis section. For the direct method, the cohort to be partitioned as TURP or non-TURP detected is the linked Medicare cancer cases. Thus, the overall incidence rates for the period 1986–1993 derived using these cases and a denominator based on the Medicare population are shown in figure 3. The indirect method uses two scaleless factors (i.e., the
TURP rate and the proportion of TURPs leading to a diagnosis of prostate cancer) from different data sources that are applied to partition the overall SEER prostate cancer incidence rates from 1973 to 1993 into TURP and non-TURP detected. The trends for the age-adjusted rates in the years of overlap are similar. Both direct and indirect methods use the same prostate cancer-to-TURP ratio in their calculations. Thus, the similar trend lines from 1986 to 1993 show that the results are comparable when using different TURP rates. The TURP-detected rates steadily increased through 1987 and declined thereafter. In contrast, the non-TURP-detected rates were fairly flat through about 1986 and then sharply increased and peaked in 1992.

Using the indirect method, the partition of total SEER prostate cancer incidence rates into TURP- and non-TURP-detected prostate cancer incidence rates are presented by year of diagnosis and age group (figure 4). The trends in the age-specific rates are each consistent with those shown for the age-adjusted rates (figure 3), although rates increase with age, consistent with age-related increases in both benign prostatic hyperplasia and prostate cancer. TURP-detected prostate cancer rates increased through the mid-1980s and then decreased. The non-TURP-detected rates remained fairly flat through the mid 1980s and then sharply increased, peaking in 1992. The proportion of prostate cancer incidence detected through TURP is a function of age and calendar period, as evident in these figures and summarized in figure 5. TURP-detected prostate cancer contributes between 18 and 53 percent of total prostate cancer incidence. The proportions tend to increase with age and rise steadily in each time period until 1988–1993, when they fell dramatically.

**FIGURE 3.** Age-adjusted (1970 standard) prostate cancer incidence rates by year of diagnosis in patients aged 65 years and older. Data sources: NHDS, SEER Program, and Medicare noncancer and linked cancer cases.
Table 2 shows the annual percent change and 95 percent confidence interval for total, TURP-, and non-TURP-detected prostate cancer incidence rates between 1973 and 1986 by age group. This time period reflects the period prior to widespread PSA testing. We report this under the column subheading "Newman et al." to reflect our data source for the proportion of TURPs leading to a diagnosis of prostate cancer in the 1970s. Given that these results are based on a single study, an alternative assumption, denoted by the column subheading "flat," is reported in the next section. The age-specific total and TURP-detected incidence trends are all significantly greater than zero, whereas the non-TURP-detected trends, except for those in ages 65–69 years, are either flat or decreasing.
FIGURE 5. Estimated percent of prostate cancer cases detected by TURP according to year of diagnosis and age using indirectly computed estimates for men aged 65 years and older, 1973–1993. Data sources: NHDS, SEER, and Medicare noncancer and linked cancer cases.

TABLE 2. Annual percent change and 95% confidence Intervals for total, TURP-*, and non-TURP-detected prostate cancer incidence rates for men aged 65 years and older in the years prior to PSA* screening, 1973–1986

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Total</th>
<th>TURP detected</th>
<th>Non-TURP detected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% change</td>
<td>95% CI*</td>
<td>% change</td>
</tr>
<tr>
<td>65–69</td>
<td>3.25</td>
<td>2.63, 3.87</td>
<td>5.47</td>
</tr>
<tr>
<td>70–74</td>
<td>2.83</td>
<td>2.43, 3.23</td>
<td>5.52</td>
</tr>
<tr>
<td>75–79</td>
<td>2.12</td>
<td>1.78, 2.46</td>
<td>6.30</td>
</tr>
<tr>
<td>80+</td>
<td>0.75</td>
<td>0.90, 1.75</td>
<td>5.85</td>
</tr>
<tr>
<td>65+</td>
<td>2.27</td>
<td>1.99, 2.56</td>
<td>5.81</td>
</tr>
</tbody>
</table>

* TURP, transurethral resection of the prostate; PSA, prostate-specific antigen; CI, confidence interval; NHDS, National Hospital Discharge Survey.
† Based on NHDS* data and on the probability of TURP leading to a diagnosis of prostate cancer that assumes a 57% increase from 1973 to 1978 (25), as described in Materials and Methods.
‡ Based on NHDS data and on the probability of TURP leading to a prostate cancer diagnosis derived from 1986 to 1990 Medicare noncancer and linked cancer cases applied to the years 1973–1985.
§ Based on rates age-adjusted to the 1970 standard.
 Distribution of TURP and non-TURP cases

Table 3 shows the distribution of cases (percent) over the levels of historic stage and grade according to TURP and non-TURP status. TURP cases displayed earlier stage and lower grade than did non-TURP cases. TURP-detected tumors have low biologic potential and may not be surgically treated. This may explain why only 3.5 percent of the TURP-detected cases and 22.5 percent of non-TURP-detected cases had a radical prostatectomy (data not shown). The relatively low levels of radical prostatectomy among TURP cases may also be due to more comorbid disease.

Sensitivity analysis

To account for possible inaccuracies in Medicare procedure billing dates and SEER Program diagnosis dates, we assumed TURPs occurring within 7 days of the month of diagnosis with prostate cancer were associated with the diagnosis. Reducing the time window in which a TURP procedure was associated with a prostate cancer diagnosis from the month of diagnosis ±7 days to just the month of diagnosis made little change in the results. For example, the proportion of TURP-detected prostate cancer changed from 48 percent (figure 5) to 47 percent in cases diagnosed between 1983 and 1987 and from 25 percent (figure 5) to 24 percent for cases diagnosed between 1988 and 1993. Changes in the earlier two periods were less than 1 percent.

Because of uncertainty about whether a TURP or a needle biopsy led to a diagnosis, the results reflect cases that had a TURP but no needle biopsy within the selected time window. Yet the choice to delete cases that had both a TURP and a needle biopsy during the time window likewise had little effect on the results. When these cases were included, the proportion of prostate cancer detected through TURP increased minimally from 48 to 49 percent for cases diagnosed in 1983–1987 and from 25 to 27 percent for cases diagnosed between 1988 and 1993. There was less than 1 percent change in the earlier two periods.

We based our results on the dramatic increase in the proportion of TURP leading to a prostate cancer diagnosis reported by Newman et al. (25). As an alternative to these estimates, a reasonable upper bound on the proportion of TURP leading to a prostate cancer diagnosis in 1973–1977 was assumed to be the same proportion as that used in 1978–1985. In table 2 under the subheading flat, we present the annual percent change in TURP and non-TURP-detected prostate cancer incidence by age group, assuming that the proportions of TURP leading to a prostate cancer diagnosis were the same in 1973–1977 as those we used in 1978–1985. The annual percent changes for TURP-detected cases in each age group remains significantly greater than zero, and the non-TURP-detected cases are not significantly positive for ages 75–79 and 80 years and older. Hence, even in the case of the upper bound, we still find that TURP explains some of the increase in prostate cancer incidence rates for each age group and perhaps all of it for ages 75–79 and 80 years and older. The two lines with plus symbols in figure 3 reflect the TURP and non-TURP-detected, age-adjusted prostate cancer incidence rates for men aged 65 years and older when the proportion of TURPs leading to a diagnosis is assumed to be flat between 1973 and 1977.

DISCUSSION

This study has assessed the changing role of TURP in prostate cancer diagnosis. TURPs have had an influence on both the level and the trend in prostate cancer incidence. In men aged 65 years and older, between 20 and 50 percent of incident cases of prostate cancer are diagnosed through a TURP. It is difficult to assess how many of these cancers would have gone undetected or been detected through other methods. Nevertheless, if we assume that most of the TURP-detected cancers would not have been detected otherwise, then most of the increase in incidence from 1973 through 1986 can be attributed to TURPs.

Symptoms for prostate cancer are similar to those caused by less serious, yet more common, health problems, such as benign prostate hyperplasia (BPH) or urinary tract infection. The method of medical management for men presenting with obstructive symptoms has evolved with changes in medical technology and improvements in the medication or treatment of BPH. Throughout the study period, pivotal changes in medical and screening practices help to explain the results we observe in this study.
Endoscopic techniques for relieving obstructive effects of an enlarged prostate were first developed in the 1930s (30). However, limitations of the equipment inhibited wide acceptance of the TURP procedure until the early 1970s, when rod-lens telescopes and improved endoscopic illumination transformed the TURP procedure into a treatment thought by many urologists to be ideal for relieving symptoms accompanying an enlarged prostate (30). In the 1970s, suspected prostate cancer was usually diagnosed by extracting prostate tissue using a core biopsy, a painful procedure with potential complications. Digital rectal examination, with sensitivity of only 50 percent and specificity of 94 percent (31), was the major clinical diagnostic tool used to make a differential diagnosis between BPH and prostate cancer. Improvements in TURP technology in tandem with the potential discomfort and complications of a core needle biopsy may have led physicians to consider TURP as both a diagnostic and a therapeutic procedure, particularly for men who were not considered candidates for more radical procedures. This may have contributed to the observed increase in TURP procedure rates, particularly in older men who have higher prevalence of symptomatic BPH.

In addition to an increased use of TURP, we observed that the proportion of TURPs leading to a prostate cancer diagnosis between 1973 and 1978 increased. This rise in the prostate cancer-to-TURP ratio may have resulted from an increase in the number of prostatic chips routinely examined by pathologists during this time (25).

Starting in the mid-1980s, several developments led to a decline both in the TURP rate and the proportion of TURPs leading to a diagnosis of prostate cancer. First, in 1985, the Food and Drug Administration (FDA) approved PSA testing for monitoring possible recurrence of prostate cancer in men being treated for the disease (32). However, a sharp increase in prostate cancer incidence rates between 1985 and 1992 suggests that PSA procedures were also being used to assist in detecting prostate cancer (2), although the FDA did not approve PSA for that purpose until August 1994 (32). The rapid increase in use of PSA has been reported for men aged 65 years and older, from 1,430 to 18,000 per 100,000 men between 1988 and 1991 (17). Second, the fine-needle, spring-driven biopsy gun under transrectal ultrasound guidance and the fine-needle aspiration biopsy also gained widespread acceptance in the United States in the late 1980s (33–38). Reasons for acceptance of fine-needle biopsy include greater ease in performance, including the ability to be done in an outpatient setting without anesthesia, and lower rates of complications than typically result from standard core biopsy (33–38). Between 1986 and 1991, use of needle biopsy more than tripled in men aged 65 years and older, from 685 to 2,600 per 100,000 men (17). This increase may, in part, reflect that the ease of biopsy had resulted in a lower threshold for proceeding with a biopsy, even if the prior test indicated only a possibility of prostate cancer. Furthermore, the greater reach of needle biopsy may have been preferred, with the improved understanding that the majority of prostate cancers are found in the peripheral zone closest to the rectal wall (70–75 percent) compared with the transitional zone surrounding the urethra (about 20 percent) or the central zone (5–10 percent), from which TURP tissue is taken (39, 40).

PSA testing and needle biopsy had a major impact on the frequency of TURP as well as on changing the composition of the clinical characteristics of men undergoing TURP. As more men underwent PSA testing and needle biopsy, more men with concurrent prostatic hypertrophy and prostate cancer were identified as having prostate cancer without undergoing a TURP. The majority of these men underwent curative local therapy, such as radical prostatectomy or radiation therapy. As a result of the removal of cancer cases from the potential pool of TURP candidates, the remaining group of men who underwent TURP were more likely to have BPH without a simultaneous cancer diagnosis, resulting in a lower prostate cancer-to-TURP ratio.

In the early 1990s, new drug therapy (e.g., finasteride) was developed as an alternative to TURP for treating BPH. The efficacy and safety of finasteride (marketed as Proscar, manufactured by Merck & Co., Inc., West Point, Pennsylvania) as an inhibitor of the hormone that is involved with prostate enlargement was established in controlled studies in the early 1990s (41–43) and approved by the FDA in 1992 (43). Two other drugs, known as alpha blockers, were later approved by the FDA for relieving bladder outlet obstruction (terazosin, marketed as Hytrin and manufactured by Abbot Laboratories, Abbott Park, Illinois, in 1993, and doxazosin, marketed as Cardura, manufactured by Roche Laboratories, Nutley, New Jersey, in 1995 (43)). While we can only speculate about the impact of medical treatment on the TURP procedure rate and on the proportion of TURPs leading to a prostate cancer diagnosis, it seems reasonable to expect that both declined as a result.

Between 1993 and 1995, SEER-based prostate cancer incidence rates fell in a similar fashion across all stage categories (on a relative scale), but most among well-differentiated tumors (44). The changes in the early stage and well-differentiated tumors may be attributed,
in part, to decreased use of TURP, since TURP-detected cases tend to be early stage and well differentiated.

Potential biases may result from the exclusions made in our study. Recall that exclusions were made of cases who had no match to Medicare data, were enrolled in an HMO, or had no known month of diagnosis. We have no reason to believe that those without linked records were more or less likely to be diagnosed through a TURP. In addition, the small number deleted because of missing month of diagnosis will not have a statistical impact on our sample. Of the excluded Medicare beneficiaries enrolled in an HMO, it is difficult to draw conclusions from the literature about whether they are more or less likely to be diagnosed through a TURP. Two survey studies have shown that Medicare HMO enrollees compared with the fee-for-service population tend to be healthier, with slightly better overall and functional health status, fewer limiting physical activities, and fewer serious chronic conditions, such as cardiovascular disease (45, 46). These findings suggest that men in HMOs may be better candidates for more radical surgery as their underlying health status is better than that for men in the fee-for-service setting. Older men with significant comorbid conditions may choose to have a TURP because they are unable to undergo more radical surgery. However, a study by Greenwald and Henke (47) involving care provided from 1980 to 1982 in a single HMO showed that men diagnosed with prostate cancer were less likely to have surgery, although the type of surgery, whether prostatectomy or TURP, is not reported in the analysis.

In conclusion, the data from this study have application for cancer surveillance. An important part of cancer surveillance is to understand factors that influence changes in cancer trends. From our analysis, it is clear that TURP has played an important role in prostate cancer detection in the 1970s and 1980s, explaining much of the increase in rates between 1973 and 1986. In more recent years, with the availability of PSA and thin-needle biopsy, the importance of TURP in prostate cancer detection declined, helping to explain some of the decrease in incidence. This decline will likely continue in future years as medical treatment of BPH improves. In the most recent years, PSA has contributed to the changing trend in prostate cancer incidence rates. An understanding of the background trend (including TURP-detected prostate cancer) is necessary to isolate the impact of PSA on the trends.

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