

THE INCIDENCE OF CANCER OF THE BLADDER AND PROSTATE IN CERTAIN OCCUPATIONS.

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(*From the Cancer Hospital Research Institute, London.*)

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I. MATERIAL EXAMINED.

THE results given below are derived from an examination of death certificates of cases of cancer and papilloma of the bladder in both sexes, and of cancer of the prostate, from England and Wales between 1921 and 1928. The total numbers of certificates examined are shown in Table I; from the whole series of 13,965 cases those relating to cancer of the bladder in males, and cancer of the prostate,

Table I. *Death certificates examined.*

	Cancer of bladder	Papilloma of bladder	Cancer of prostate
<i>Males.</i>			
1921	589	86	—
1922	641	109	—
1923	647	114	—
1924	711	115	1022
1925	745	115	1116
1926	723	134	1145
1927	753	151	1172
1928	812	150	1353
	5621*	974	5808*
<i>Females.</i>			
1924	350	—	
1925	337	46	
1926	340	51	
1927	384	54	
	1411	151	

* The difference between these totals and those given in Table II is due to the exclusion from the latter Table of seven cases of cancer of the bladder, and four cases of cancer of the prostate, occurring in persons under 20 years of age.

numbering 11,429, were chosen for study in detail, as in these classes the largest numbers and the best occupational data are available.

The two classes which were not used for exact tabulation of the occupations, namely, papilloma of the bladder, and cancer of the bladder in females, were put aside for the following reasons: (a) The cases of papilloma, which amount to little more than one-sixth of those of cancer of the bladder, are insufficient in number; but data were obtained from this series, in regard to the chemical trades especially, which will be studied in future when more figures are available. This class is valuable because the proportion of correct diagnoses is probably high and the inclusion of any prostatic or rectal tumours is unlikely. (b) The death certificates of women did not yield a sufficient number in which any industrial occupation was recorded. Thus, in 1925, only 15 of the 337 death certificates for cancer of the bladder in women recorded any occupation not connected with domestic, nursing or teaching work.

II. SOURCES OF ERROR.

The analysis of such material as is afforded by the 11,429 certificates of cancer of the bladder in males, and of the prostate, encounters many difficulties, which may be classified under three headings.

First, it is necessary to know the total number of persons following any given occupation. This is learned from the Census results (in this case the Census of 1921) but (1) the figure given by the Census cannot be relied upon throughout the 10 years until the next Census; (2) the utility of the Census figures in the present investigation depends upon the possibility of obtaining in the death entries such detailed information in regard to occupation and industry as would enable the resultant figures to be related to the Census figures. It was not possible for example to ascertain a population at risk in regard to certain workers in chemicals and chemical manufactures in whom we were interested, and the corresponding death certificates, from which very interesting results might have been expected, could not be used statistically.

Second, with regard to the smaller occupations. Some of the most interesting from the present standpoint (patent fuel manufacture, tar distilling, chimney sweeping) employ a few thousand men only, who will yield but very few cases of cancer of the bladder even if the incidence is high. Hence the sampling error will be large even over a period of 8 years. Three of the four deaths of tar distillers from cancer of the bladder recorded in Table III occurred in two of the eight years (1922 and 1923).

Third, with regard to the individual entry in the death register. (1) This gives no information about the length of time during which the deceased followed the occupation named. (2) In some cases, especially in the case of deaths occurring in institutions, the information available to the Registrar at the time of registration is not so detailed as that supplied by the man himself at the Census. (3) Incorrect diagnosis is of course a possible source of error which is unavoidable in all such material.

In the work recorded here, an attempt has been made to avoid these inaccuracies by special enquiry into individual cases in some occupations (patent-fuel labourers, gas-works engine and crane drivers, gas fitters, gas stokers, gas-works inspectors and foremen, gas workers and labourers (not stokers), gas-producer men, coke-oven workers, brick kiln and oven men, blast furnacemen and labourers, dye mixers and dyers) where the smallness of the number employed made an error in a single death certificate most serious. Such enquiry was made in fifty cases of cancer of the bladder, chiefly of the more recent years (1924–1928), from relatives, fellow-workmen and employers of the deceased, with reference especially to the exact nature of the occupation and the length of time for which it had been pursued. Of these fifty cases, forty-four could be traced. In forty-one the reliability for our purpose of the information given on the death certificate was confirmed. In one case the short time for which the occupation had been followed (5 to 6 months) caused it to be rejected as a factor, although the entry was of course perfectly correct. In two cases the industry rather than the occupation in that industry had been recorded. Thus an “alkali labourer” was found to have worked for 32 years at a gas-producer plant, and the case was transferred accordingly to the class of gas-producer men.

The minimum duration of exposure necessary to produce an occupational cancer cannot be stated, and this question is a constant source of difficulty in such work as is presented here. In this series we have rejected the case of a gas-works labourer who had been employed in that work for not more than 5 or 6 months before death, and have retained the cases of a dyer with 2 years' and of a gas-producer man with 5 years' duration of employment before death.

The objection may be raised that if special enquiry be made into any of the cases in Table III it should be made into all. But (1) to investigate, in places scattered all over England and Wales, the accuracy of over 1400 death certificates was not practicable for us. (2) The risk of serious error is greatest in the smaller groups. Thus, if the certificate relating to one of four patent-fuel labourers is incorrect, the error is serious; but it is extremely unlikely that 25 per cent. of the 160 farmers are described incorrectly. (3) The comparatively small number of occupational terms in some of the larger groups causes less classification difficulty in those groups than in some of the smaller ones. Thus, an agricultural labourer can hardly be misnamed, whereas a tar distiller may be described as a by-product worker, or a stillman in a chemical works.

The occupational classification in use at the General Register Office was revised in 1921. The change was made in accordance with a resolution of the British Empire Statistical Conference of 1920 in favour of separate and independent tabulations by occupation and by industry. The classifications used in 1911 and earlier were only in part occupational, being largely industrial in nature. The change precludes the possibility of an exact comparison with previous Census results (see *General Report, Census of England and Wales, 1921*, p. 86), or with the data on the occupational incidence of cancer in England and

Wales in 1910, 1911 and 1912, published by the Medical Research Council (Young, Russell, Brownlee and Collis, 1926). In the last-named report the occupations associated with coal gas, tar and pitch, do not appear in the tables devoted to cancer of the bladder and prostate.

III. METHOD OF CALCULATION.

In estimating the occupational incidence of any form of cancer it is, of course, necessary to correct for age distribution, for an occupation employing a large proportion of older men will yield more cases of cancer apart from any aetiological factor. The Census Occupation Tables give the age distribution, in decennial periods, of the whole population of males, and also of those following each one of the recognised occupations, at the time of the Census. The number of cases of cancer of the bladder and of the prostate occurring in the whole male population in each of these decennial periods during the years (Table I) in question was obtained from material at the General Register Office. The comparison of the various occupations with the general population is then a sum in proportion. In Table II the method of calculation is shown in detail by three

Table II. *Cancer of bladder and prostate.*

	Age group							Total aged 20 and upwards	Total registered deaths	Ratio of registered to 100 calculated deaths
	20-	25-	35-	45-	55-	65-	70 and upwards			
All males										
Population	1,448,385	2,621,280	2,496,375	2,133,179	1,382,843	449,363	530,867	11,062,292	—	—
Deaths: Bladder	10	28	176	668	1621	1116	1995	5614	5614	100
Prostate	4	3	28	256	1338	1255	2920	5804	5804	100
Farmers										
Population	7,358	37,688	57,806	63,325	52,317	19,694	29,405	267,593	—	—
Deaths: Bladder	0.0	0.4	4.1	19.8	61.5	48.9	110.5	245.2	160	65
Prostate	0.0	0.0	0.6	7.6	50.6	55.0	161.8	275.6	236	86
Tar-Distillery Workers										
Population	266	595	622	594	399	123	66	2,665	—	—
Deaths: Bladder	0.0	0.0	0.0	0.2	0.5	0.3	0.2	1.2	4	333
Prostate	0.0	0.0	0.0	0.1	0.4	0.3	0.4	1.2	1	83
Patent-Fuel Labourers										
Population	313	532	444	306	143	44	29	1,811	—	—
Deaths: Bladder	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.5	2	400
Prostate	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	1	250

examples, namely, one large class (farmers), and two very small ones (tar-distillery workers, labourers at patent fuel works). All the ratios given in Table III were obtained in this way.

Table II shows, for example, that all the 2,133,179 males in England and Wales between the ages of 45 and 55 produced 668 fatal cases of cancer of the bladder in the years 1921 to 1928. The 63,325 farmers in this age-group should, at this rate, give 19.8 cases. One proceeds in this way through each age-group and adds up the total cancers of the bladder for a hypothetical general population of the number and age distribution of farmers, obtaining a total of 245.2. But the actual number given by the death certificates of farmers is 160. The ratio for farmers is therefore $\frac{160 \times 100}{245.2} = 65$.

IV. INCIDENCE OF CANCER OF THE BLADDER.

The occupations named in Table III employed, at the time of the Census in 1921, 3,042,990 out of the 11,062,292 males aged 20 and upwards, and they include most of the men engaged in the two largest industries in the country, namely agriculture and coal-mining. The Table includes 1456 out of the 5614 cases of cancer of the bladder, and 1593 out of the 5804 cases of cancer of the prostate, occurring in the whole population in question. These figures for the three totals, and the fractions of these three totals which are dealt with in Table III show nearly the same ratio; thus

$$\frac{11,062,292}{3,042,990} = 3.6, \text{ and } \frac{5614}{1456} = 3.8, \text{ and } \frac{5804}{1593} = 3.6.$$

Of course, many other occupations might have been considered, but the object of this investigation was primarily the incidence of cancer of the bladder upon workers in the gas, tar and chemical industries.

The results given in the table suggest the following comments:

(1) The ratio in all the open-air occupations not exposed to industrial vapours and dusts (gardeners, farm bailiffs and foremen, agricultural labourers and shepherds, farmers) which together include over 920,000 men, is low (87, 74, 65, 65).

(2) The horse drivers, grooms and horse keepers show likewise low ratios (88, 62), though many of these men must be town-dwellers.

(3) The coal-mining industry shows a ratio below 100 in five out of six subdivisions (workers above ground 85, hewers 81, persons making and repairing roads 80, other workers below ground 53). The exceptional group is that of "persons conveying material to the shaft," with a ratio of 171. Probably this high figure is due to lack of conformity between the descriptions of occupation given by the men themselves in the Census schedules and the description obtained by the Registrar at the time of death, and is not to be taken as reliable. The idea suggests itself that these persons engaged in the traction work of the mine are most exposed to lubricating oil, but this matter would need special enquiry. If the three groups of underground workers other than hewers (persons conveying material to the shaft, persons making and repairing roads, other workers below ground) are pooled, a total of fifty-four deaths is obtained with a ratio of 78.

(4) The table shows that, out of the forty-six occupations examined, fifteen have ratios for cancer of the bladder greater than 150. These fifteen occupations may now be considered in some detail. In five, and possibly in eight, of them there is exposure to coal gas, tar, or pitch; in one to lubricating oil; and in two to tobacco.

(a) Five of the fifteen occupations (gas stokers, gas fitters, tar distillers, gas-works engine and crane drivers, patent-fuel labourers) involve exposure to coal gas, tar, or pitch, the last three of these occupations showing the highest ratios on the list, namely 333, 400 and 400. The numbers of deaths in some of

Table III. *Cancer of bladder and prostate.*

The occupations are placed in the descending order of the ratio of registered to 100 calculated deaths from cancer of the bladder.

	Population Age 20 and upwards	Calculated deaths		Registered deaths		Ratio of registered to 100 calculated deaths	
		Bladder	Prostate	Bladder 1921-28	Prostate 1924-28	Bladder	Prostate
Labourers at patent fuel works ...	1,811	0.5	0.4	2	1	400	250
Gas-works engine and crane drivers...	1,915	1.0	—	4	None	400	—
Tar-distillery workers...	2,665	1.2	1.2	4	1	333	83
Cellarmen ...	5,844	2.6	2.5	6	5	231	200
Lithographic and process engravers...	4,440	1.3	1.2	3	2	231	167
Tobacco manufacture...	7,309	2.7	2.7	6	5	222	185
Gas-works managers ...	1,614	0.9	0.9	2	3	222	333
Gas fitters ...	11,343	3.9	3.8	8	8	205	210
Brick kiln and oven men ...	5,143	2.0	1.8	4	4	200	222
Cotton spinners and piecers ...	32,448	10.6	9.7	21	14	198	144
Coal miners—persons conveying ma- terial to the shaft ...	72,821	8.2	6.2	14	6	171	97
Tanners, leather dressers, curriers; skilled workers ...	18,372	10.1	10.4	17	15	168	144
Brick and plain tile makers ...	7,868	3.8	4.1	6	4	158	98
Gas stokers ...	11,931	4.5	3.5	7	8	156	229
Tobacconists and their assistants ...	14,470	7.2	7.3	11	9	153	123
Painters ...	159,809	78.2	74.8	115	105	147	140
Dye mixers and dyers ...	19,423	8.3	7.8	12	12	145	154
Blast furnace enginemen ...	1,531	0.7	—	1	None	143	—
Gas-producer men ...	4,112	2.1	1.7	3	2	143	118
French polishers ...	15,048	5.6	5.2	7	10	125	192
Licensed victuallers ...	75,038	54.3	54.1	67	75	123	139
Coke-oven workers ...	9,318	4.9	3.8	6	1	122	26
Hairdressers ...	30,943	10.2	9.0	12	9	118	100
Bakers and pastrycooks ...	56,603	26.2	26.3	31	24	118	91
Gas workers and labourers (not stokers) ...	32,761	17.9	17.4	21	22	117	126
Stationary engine and crane drivers	79,226	35.8	33.9	40	35	112	103
Carpenters ...	188,199	123.6	133.0	134	114	108	86
Cabinet makers ...	31,770	18.3	19.7	19	16	104	81
Printers ...	75,454	31.1	29.5	32	32	103	108
Chimney sweeps ...	5,274	4.5	4.9	4	3	89	61
Drivers of horse-drawn vehicles ...	178,421	81.8	78.6	72	62	88	79
Gardeners ...	181,112	164.0	184.2	143	204	87	111
Coal miners—workers above ground	83,338	42.5	41.8	36	46	85	110
Gas-works inspectors and foremen ...	4,668	2.4	2.2	2	1	83	45
Coal miners—hewers ...	487,304	139.3	126.7	125	114	81	90
Coal miners—persons making and re- pairing roads ...	54,696	27.5	26.2	22	20	80	76
Cotton weavers ...	38,928	16.7	16.6	13	14	78	84
Farm bailiffs and foremen ...	23,129	13.5	13.6	10	21	74	154
Plumbers ...	41,336	15.5	14.4	11	8	71	56
Agricultural labourers, including shep- herds... ..	449,587	294.4	319.7	191	231	65	72
Farmers ...	267,593	245.2	275.6	160	236	65	86
Grooms and horsekeepers ...	36,055	21.0	21.2	13	22	62	104
Locomotive engine drivers, firemen and cleaners... ..	88,009	28.6	27.0	16	33	56	122
Coal miners—other workers below ground ...	79,174	33.9	30.9	18	30	53	97
Blast furnacemen and labourers ...	13,363	6.0	5.7	3	4	50	70
Barmen ...	16,112	4.1	3.3	2	2	49	61
Total...	3,042,990			1456	1593		

these occupations is very small, and is therefore liable to a large sampling error, but the concordant tendency of the evidence from the five groups seems to have some cumulative weight. The only branches of the gas industry which have lower ratios are (1) "Gas workers and labourers (not stokers)" (ratio 117), who include probably a number of unskilled labourers who may not have been long in this employment; and (2) "Gas-works inspectors and foremen" (ratio 83), who are represented by two persons only, a gas-works foreman and a gas-meter inspector. The occupation of gas-works engine and crane driver is included here because these men would be exposed to the volatile products of the gas works.

The sixth group from the coal gas industry showing a ratio above 150 is that of gas-works manager (ratio 222), but we do not know whether the two persons represented in the table had been subjected to the atmosphere of the gas works. This group gives also the highest figure in the table (ratio 333) for cancer of the prostate.

Of the four brick kiln and oven men (Table III, p. 130) one was described at death as a kiln setter, and investigation showed that setting kilns had been his main occupation. The second was described as a kiln man; on investigation he was found to have been so employed for the last 5 years; previously he had been a brick setter for 10 years, and before that on various jobs in the works for 15 years. The third and fourth were described as brick burners, but one of these had been mainly a kiln setter, flue cleaner, and in his spare time a chimney sweep, while the other was known to have been at the brick works all his working life, of which the last 10 years were certainly spent in brick burning only.

The presser comes into contact with "brick oil" or "moulding oil," which consists mainly of the creosote fraction of coal tar. The setter, in handling the bricks after moulding, is also exposed to the same oil, but in a warmer atmosphere when inside the kiln. Hence in three, if not four, of these cases prolonged contact with creosote oil is at least probable.

During the period in question (1921-8) there was also one death from cancer of the bladder in a stationary engine man at a creosote works. The age distribution of the men in this occupation is not available; hence the case does not appear in Table III.

(b) One occupation is associated certainly with exposure to lubricating oil, namely that of cotton spinners and piecers (ratio 198). The great liability of cotton spinners to occupational epithelioma of the skin due to mineral oil is of course well known. Table IV shows that in six years no less than 463 cases of cancer of the skin were notified in cotton mule spinners, while in the same time five cases only were notified in cotton weavers. With these numbers one may compare those in Table III for cancer of the bladder which show a high ratio (198) for cotton spinners and piecers, and a low one for cotton weavers (78). The numbers engaged in the two occupations are not very different (spinners and piecers 32,448; weavers 38,928). Possibly the incidence of cancer of the bladder upon cotton spinners and piecers is even understated here,

Table IV. *Showing the industries in which occurred the 546 cases of skin epithelioma notified as due to shale oil or mineral oil from 1923 to 1928 inclusive (England and Wales).*

Industry	Total	Industry	Total
Shale oil refining	30 (1920 to 1928)	Woolen	3
Cotton: Blowing	1	Jute	1
Carding	7	Engineering	20
Mule spinning	463	Coal mining, pump oiler... ..	1
Ring spinning	2	Oil blending	3
Doubling	1	Matches, oil storeman	1
Weaving	5	Gunsmith	1
Winding	1	Brewing engineer... ..	1
Oiler and greaser... ..	1	Stone sawing, crane driver	1
Engine tenter	1		
Engineer	2		
		Total... ..	546

Table V. *Showing the industries in which occurred the 439 cases of skin epithelioma notified as due to pitch, tar or tarry products from 1920 to 1928 inclusive (England and Wales).*

Industry	Total	Industry	Total
Patent fuel manufacture	183	Cable manufacture	6
Tar distilling	118	Creosoting timber	5
Coal gas manufacture	65	Anthracene manufacture	4
Pitch loading (wharfs, etc.)	22	Net fixing	3
Coke ovens	8	Barge repairing	2
Brick, tile and pipe manufacture	6	Felt proofing	2
Producer gas manufacture	6	*Other industries	9
		Total... ..	439

* Include manufacture of brattice cloth 1, asphalt troughs 1, electric brushes 1, bitumastic paint 1, sails 1, insulators 1, and the occupations of creosoting moulds (steel works) 1, cable handling (telegraph construction) 1, and roadman (local councils) 1.

because during the last few years the cotton trade has been depressed and men in the earlier stages of the disease may have taken to other occupations, which would be entered upon the death certificates.

(c) Both occupations connected with tobacco give rather high ratios (tobacco manufacture 222, tobacconists and their assistants 153).

(d) Cellarmen show a high ratio (231), but another occupation associated with alcohol (barmen) has a very low one (49), and that of licensed victuallers a ratio near the normal level (123).

(e) The two remaining classes with ratios above 150 (lithographic and process engravers 231, tanners, leather dressers and curriers 168) are both concerned with work which is chemical in character.

(5) Gas-producer men show a ratio of 143. Neither coke-oven workers (122) nor chimney sweeps (89) have a high ratio, though both are liable to cancer of the scrotum. The very widespread use of producers is a recent development and there must be many workers who have not been very long in this employment. Exposure to lubricating oil does not always give a high ratio, for locomotive drivers, firemen and cleaners show a low one; but probably this class has a high standard of personal cleanliness. Also, locomotive drivers are under constant medical inspection and are drafted to other work if they show any failure of stamina, and hence the deaths of such men will be assigned to other occupa-

tions. Blast furnacemen and labourers show a low ratio (50); two of the three cases were traced by enquiry, and the occupation of one of these was found to have been that of a labourer and gas stoker at a gas works maintained for producing ordinary coal gas to light the blast furnace.

This section may be summarised by bringing together from Table III the figures relating to the eleven occupations which may involve exposure to coal gas, tar, pitch or soot. The ratio in nine of these is above 100, and in six is above 150.

Cancer of bladder.

	No. of deaths	Ratio
Patent-fuel labourers	2	400
Gas-works engine and crane drivers ...	4	400
Tar-distillery workers	4	333
Gas-works managers	2	222
Gas fitters	8	205
Gas stokers	7	156
Gas-producer men	3	143
Coke-oven workers	6	122
Gas workers and labourers (not stokers)	21	117
Chimney sweeps	4	89
Gas-works inspectors and foremen ...	2	83

V. OCCURRENCE OF TUMOURS OF THE SKIN, AND OF THE BLADDER,
IN THE SAME PERSON.

Workers exposed to coal tar and pitch may develop papilloma or carcinoma of the skin before a tumour of the bladder is known to be present. By special enquiry into case histories we have found two instances of this in our own series (Table III, p. 130), and we have learned of two more from the literature. Among our own cases: (1) In a patent-fuel worker papillomata of the face had been diagnosed four times between 1916 and 1926; in 1927 he died of cancer of the bladder. (2) The other patent-fuel worker suffered from an "ulcerating wart" on the wrist in 1921 and died of cancer of the bladder in 1928. (3) In a German journal (Posner, 1898) there is an extremely scanty report of the co-existence of a bladder tumour with a scrotal cancer in a tar worker ("Herr Posner (Berlin) hat zweimal Blasentumoren bei Arbeitern aus einer Naphthol resp. Theerfabrik beobachtet, im letzten Fall gleichzeitig mit einem typischen Skrotalkrebs"). (4) O'Donovan (1920) records a case admitted to the London Hospital. "S. V., aged 67 years, worked in tar for 26 years, and after 11 years developed 'eczema' and warts on the arms and legs. Four and two and a half years before his admission he was operated on for 'tar warts,' and seven weeks before his admission he had haematuria, which on cystoscopy... proved to be due to an inoperable carcinoma of the bladder." Elsewhere in the paper this man is described more exactly as a tar distiller.

These cases are of interest also in connection with the possibility that a protective action against the development of cancer in any one part of the body may be exerted by an existing benign or malignant tumour in another part (cf. Murray, 1923). The prospect here does not seem very hopeful.

VI. THE RELATIONS BETWEEN CANCERS OF THE SCROTUM,
OF OTHER PARTS OF THE SKIN, AND OF THE BLADDER.

It is perhaps permissible to attempt, in a purely tentative way, some correlation between the data given in Table III and those which we possessed previously about occupational cancers. There appear to be some curious differences in the incidence of these cancers; Table VI is intended to present, not any conclusive results, but suggestions for the further investigation of the apparent differences. These may be real, or may be due to inadequacy of the data, especially in regard to cancer of the bladder; in either case they show the need for much further research upon industrial cancer.

Table VI.

	Cancer of					
	Scrotum	Other skin				Bladder
Pitch workers	+	+	+	+	+	+
Tar workers	+		+	+		+
Chimney sweeps	+	+		+		-
Mule spinners	+	+		+		+
Shale-oil workers	+		+	+		-
Chemical workers	-			-		+
Gas-producer men	+			-		-
Coke-oven men	+	+		+		-

The signs + and - are used here not in any exact qualitative sense, but to give a rough quantitative expression of such abundance or rarity as is suggested by the available data derived from deaths or notifications during life. The proportions indicated by single or multiple + signs in the first two columns of the table are based on data given in earlier papers (Kennaway, 1925; Bridge and Henry, 1928; Henry, 1928), which need not be set out again here, and on material as yet unpublished. Thus, in mule spinners about two-thirds of cancers of the skin occur on the scrotum and one-third elsewhere, while in the tar workers this relation is reversed. Dr Alexander Scott, whose monograph (1923) contains practically everything that is known about cancer in the shale oil industry, has been so kind as to inform us that in his 35 years' experience he has never known a case of cancer of the bladder in a shale-oil worker, but no special enquiry, such as the systematic searching of local death registers, has been made on this point. By "chemical workers" here is meant a large class including those generally spoken of by writers on cancer, often on very inadequate grounds, as "aniline dye workers."

The apparent absence of occupational cancer of the bladder in the smaller groups (shale-oil workers, sweeps) may be due to the much less frequent occurrence of this form of cancer, in comparison with that of the skin. This is shown by the figures given in Table VII which are derived from the series in Tables III, IV and V.

Table VII.

		Notified cases of cancer of skin	Fatal cases of cancer of bladder
1921-1928	Patent fuel manufacture	153	2
	Tar distilling	114	4
	Mule spinning	463 (1923-1928)	21 (1921-1928)

The results suggest the idea that the skin serves as a very effectual first line of defence to the urinary tract; but of course the substances producing cancer of the skin, and of the bladder, may be different, and the latter may enter through the respiratory or alimentary tract. The whole group of phenomena summarised, very inadequately, in Table VI requires much further investigation.

VII. INCIDENCE OF CANCER OF THE PROSTATE.

The examination of the death certificates of cases of cancer of the prostate was intended to provide a control upon those of cancer of the bladder, in which an occupational factor was probable; thus it was hoped that the occupations showing an exceptionally high incidence of bladder cancer would show a more or less normal incidence of prostatic cancer. But the selection of cancer of the prostate as a control was probably an unfortunate one, for two reasons. First, the prostate may not be altogether immune from the liability to industrial cancer which affects the upper parts of the urinary tract. This possibility has been suggested by Oppenheimer (1926), who has recorded a case of cancer of the prostate, and one of cancer of the posterior part of the urethra, in chemical workers. Second, cancer of the prostate may be mistaken for cancer of the bladder, or *vice versa*, more especially where the medical attendant has no opportunity for special knowledge of urology, nor for the performance of autopsies; under these conditions the more likely of the two possible errors is that cancer of the prostate will be recorded as cancer of the bladder.

It is difficult to decide which organ, other than the prostate, would have been most suitable as a control unaffected by occupational conditions. The whole respiratory tract, and the upper alimentary tract, including the stomach, are obviously unfitted for this purpose, while the recorded number of cases of intestinal cancer may be affected considerably by errors of diagnosis. Probably cancer of the rectum would have provided the best control figures, for in this case the influence of external factors is improbable, and the diagnosis will be generally correct.

Some comments may be made upon the figures for cancer of the prostate given in Table III (p. 130).

(1) The three occupations which show the highest ratios for cancer of the bladder (patent-fuel labourers, 400; gas-works engine and crane drivers, 400; tar-distillery workers, 333) show for cancer of the prostate either no deaths at all, or a low ratio (tar-distillery workers, 83) or a fairly high one (patent-fuel labourers, 250). Hence, if any weight at all is to be attached to these figures, they indicate that these occupations predispose to cancer of the bladder rather than to cancer of the prostate. One notes also that the coke-oven workers produced six cancers of the bladder and one cancer of the prostate, although the latter disease is about 1.6 times as common as the former in the general population (Table I).

(2) But the matter is not very simple, for in the succeeding part of Table III

are several occupations in which the ratio is high for both forms of cancer. Thus:

	Ratio	
	Bladder	Prostate
Cellarmen	231	200
Gas-works managers ...	222	333
Gas fitters	205	210
Brick kiln and oven men	200	222
Gas stokers	156	229

And it is noteworthy that the cotton spinners show again a higher ratio than do the cotton weavers, although the difference is not so great as in the case of the bladder.

There seems to be nothing to help one in deciding between the various possible factors (occupational incidence upon both organs, errors of diagnosis, errors of sampling) which might be suggested to explain the above figures.

(3) The remaining occupations, with ratios for cancer of the bladder below 150, show on the whole fairly close agreement between the two series (bladder and prostate). Thus the ratios for bladder and for prostate differ by not more than twenty in the following fifteen classes: painters, gas-producer men, licensed victuallers, hairdressers, gas workers and labourers (not stokers), stationary engine and crane drivers, printers, drivers of horse-drawn vehicles, coal miners (hewers, and persons making and repairing roads), cotton weavers, plumbers, agricultural labourers and shepherds, blast furnacemen and labourers, barmen.

It is noteworthy that, in the open-air group (gardeners, farm bailiffs and foremen, agricultural labourers and shepherds, farmers), the ratio for bladder is throughout lower than that for prostate. In the wood-working group (carpenters, cabinet-makers) the reverse is seen. High figures for prostate, in comparison with those for bladder, are given by French polishers, farm bailiffs and foremen, and locomotive engine drivers, firemen and cleaners.

VIII. CANCER OF THE BLADDER AND PROSTATE IN CHEMICAL WORKERS.

Our series includes 61 fatal cases of cancer of the bladder in chemical workers (dyers, dye mixers, workers in rubber and explosives, and those engaged in all unspecified chemical processes). In only one of these groups however, namely that of the dyers and dye mixers, was it possible to ascertain the population at risk, and hence these alone of the chemical workers appear in Table III. But we have accumulated, by special enquiry into individual cases, a large amount of data upon the actual processes in which the other chemical workers were engaged, and we are utilising this information as a guide in experimental work, and in other ways.

IX. SUMMARY.

In eight out of ten occupations associated with exposure to coal gas, tar, pitch or soot the incidence of cancer of the bladder is greater than that found

in the general male population, and in five of the ten it is from one and a half to four times as great. Three of these occupations show the highest figures for incidence of cancer of the bladder observed among the forty-six occupations investigated. Various possible sources of error in these figures are discussed, of which the most serious is the smallness of the numbers of deaths involved. The corresponding data for cancer of the prostate give less consistent indications of an occupational liability. The subject needs much further enquiry, but it has seemed best to publish now, without further delay, such material as is available, rather than wait for another long term of years while more data accumulate.

A large, and quite essential, part of this investigation, namely the computing of the population for each occupation recorded on the death certificates, and the calculation of the ratios, has been carried out by members of the staff of the Registrar General, to whom we wish to express our great indebtedness. We have to thank the British Empire Cancer Campaign for a grant which enabled the special enquiry into individual cases to be made, and to record our gratitude to those who assisted so willingly in carrying out this enquiry.

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