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ROUTINELY COLLECTED LABORATORY DATA: A NEGLECTED RESOURCE

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Abstract

Medical technologists participate in research projects conducted by doctors and scientists. They should be encouraged to carry out their own research projects. Using data that is routinely generated in one's own laboratory can minimise the need for additional resources. Information contained in the laboratory's information management system (LIMS) is primarily used as a management tool. It can be utilised as a source of research material. The LIMS can be used to pose and answer research questions. Displaying your laboratory's data in an annual report is a good starting point and displaying this data over time can be an important disease surveillance tool. The type of research that it is possible to carry out on data generated by the laboratory can be used to learn more about the utilisation of your services and improve the service offered by the laboratory. It may also be used to advance medical knowledge and carry out disease surveillance.

Examples from the authors' own experience in laboratory work are given.

Keywords

Laboratory information management system, research, silicosis, surveillance, tuberculosis.

INTRODUCTION

This essay is based on the Professor Hendrik Koornhof guest address delivered on 1st September 2011 by Professor Jill Murray at the Laboratory Medicine Congress held at the Sandton Convention Centre. Following the address, Professor Hendrik Koornhof was awarded a life-time achievement award in honour of his contribution to laboratory medicine.

All health care professionals should keep abreast of the latest developments in their fields. The continuing quest for new knowledge is conducted through research. Many laboratory technologists make valuable contributions to research, however, most of the time their role is that of assistants to other health care professionals and scientists. Too few medical technologists conduct their own investigations. The absence of studies in routine laboratory practice implies a tacit assumption that current practice will not change and is therefore boring!

Reasons given for not doing research include lack of time and lack of resources. There is also the problem of which area of laboratory medicine to study and being familiar enough with the subject to develop good research questions. Research is perceived as time consuming, requiring a lot of funding and specialist knowledge. By looking carefully at the resources within one's own laboratory, the requirements for time and money can be minimised and you will be able to utilise your knowledge in your own area of expertise.

As part of the routine service, which is an integral part of patient care, all laboratories produce and retain large amounts of data. Collecting, organizing and studying this data can increase medical knowledge. Researching routinely collected data minimises the time and costs associated with data collection. In addition the data is in an area of medicine in which the laboratory has experience and expertise. Because of the expert knowledge available in the laboratory there will be an understanding of what is known and what is not; a prerequisite for the formulation of research questions and hypotheses. This paper will look at the type of data available to laboratories; how to report and display this data and the type of research questions that routinely collected data can answer.

DISCUSSION

The starting point for researching routine data is the specimen itself. Every specimen received in the laboratory has information embedded in the label. Demographic information about the patient such as age and gender will be on the label along with clinical information. There is also geographic data detailing the province, region and town of origin. This geographic data may allow you to classify the origin of the specimen as urban or rural. There will be information about the healthcare facility from which the specimen was sent such as a primary care clinic, or a district or tertiary hospital. Even the ward provides information as to whether the patient was admitted to an obstetric, pediatric, surgical or general medical ward. In addition to the information on the label, there is the test result. This may be in the form of a positive or negative result, a value, the identification of an organism or a diagnosis such as cancer.

The time that the specimen arrives in the laboratory and the time the report is issued will be recorded. This will inform you about your turn around times for the range of tests that your laboratory performs. When looking at turnaround times it is useful not just to calculate the mean time, but to look at the range and particularly at the outliers. It is the outliers that drive dissatisfaction and lead to unnecessary repeat testing.

The information received with the specimen and the test results will be recorded. Some laboratories still keep ledgers but most will record data in an electronic laboratory information management system (LIMS). The sheer volume of data can be overwhelming. In one year, the National Health Laboratory Service (NHLS) handles many millions of requests for laboratory tests. The primary focus of the record systems is business management. Although the systems were not designed to answer research questions, the use of the LIMS to generate data for research is developing rapidly. In order to extract information from the system, there needs to be cooperation with management who are releasing the information to you, and cooperation with information technologists who manage the system and are able to extract the data in a format that you can use. Later on it will be advantageous to have advice and assistance from epidemiologists and biostatisticians.

When permission and ethical approval have been obtained to use the laboratory's information and you have the means to access it, the process can start. Most organisations produce an annual report, which includes a description of the activities during the year. Presenting laboratory data in an annual report is a good place to start developing research capacity. The annual report data will raise several questions. Some of the questions may be easily explained while others will ultimately be refined into research questions. The cross sectional data in the report can tell you a great deal about your services and who is using them. It can show how well, or badly, the service is being used for patient care. Are doctors taking the service for granted and requesting tests which are not urgent at midnight? Callouts and urgent tests at night can have a big impact on a small laboratory with limited staff.

The rising cost of health care is a problem facing the whole of South Africa. One of the biggest cost drivers identified in most hospitals has been the amount of money spent on laboratory services. It is obviously in everyone's interest to utilise laboratory medicine optimally and efficiently. Research at the Chris Hani Baragwanath Hospital a few years ago found that junior doctors, who are at the forefront when it comes to ordering these tests, are generally overzealous. Most senior doctors were unable to estimate the cost of tests[1]. Producing a report on the top ten tests by volume or by cost can help formulate specimen-taking guidelines, review existing guidelines and audit their application.

Dissemination of the annual report is very important. It needs to be sent to all colleagues in the laboratory and other laboratories in your organisation. It needs to be shared with academic colleagues at tertiary institutes, clinicians that use your services and people involved in the process of policy making. This is important as annual report data can be used to estimate the magnitude of disease, to identify high-risk groups, prioritise the allocation of resources and facilitate the design of intervention programmes.

When several annual reports have been completed, data can be displayed over time. The information is now longitudinal data, which is a very powerful tool. The ongoing, systematic collection, analysis, interpretation and dissemination of data are the essence of surveillance. Surveillance can tell you about the magnitude of disease and reveal disease trends. It can assist in evaluating the efficacy of interventions and is more useful than cross sectional data for planning and prioritising resources. Longitudinal data is of great interest to policy makers. Surveillance should lead to action, which in turn should lead to health benefits or greater efficiencies and improvements within the health service.

A display of the results of tests may be interesting. Some doctors will request tests and the results will be normal in the vast majority of cases. Other doctors requesting the same tests may get a much larger proportion of abnormal results. This scenario would raise questions concerning the local situation and circumstances that dictate requests for tests. The results may show some unexpected figures, clusters, anomalies or outliers which may be of interest and reveal a subset of patients that warrant detailed description as a case report or case series. Clusters of patients with a particular disease are a signal to epidemiologists and are of great interest and may indicate a change that needs to be investigated.

To illustrate the use of routinely collected data some examples

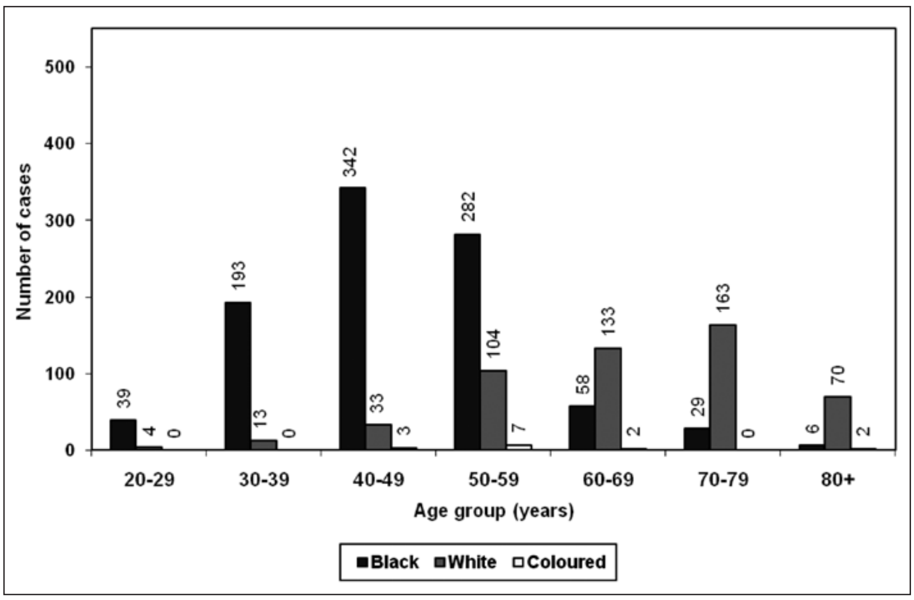

Figure 1: Distribution of autopsies by age and population group in 2010.

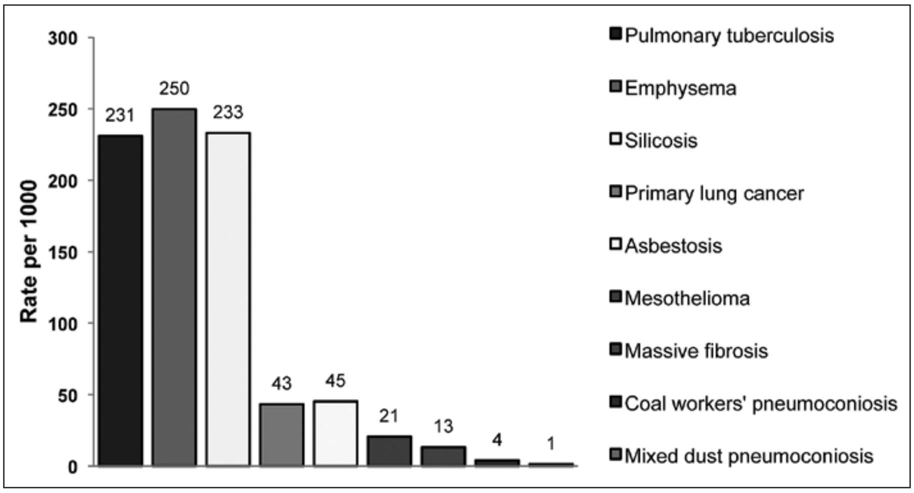

Figure 2: Overall rates of lung disease in the South African mining workforce for 2010.

will be presented using the data generated by the laboratories of the National Institute for Occupational Health (NIOH), which is a division of the NHLS.

In the pathology laboratory at the NIOH, if the next of kin agree, the lungs of deceased miners are examined for compensation purposes. An autopsy is performed regardless of the clinical cause of death. Compensable diseases include silicosis and emphysema, which can result from the inhalation of silica dust generated in the course of mining for gold. Because silicosis is an important risk factor for the development of tuberculosis it is also considered an occupational disease in miners. Compensable diseases caused by asbestos fibres include asbestosis, lung cancer and mesothelioma. Exposure to dust in coal mines leads to emphysema and coal workers' pneumoconiosis.

A detailed pathological examination is performed and a report issued for the compensation commissioner and the test results are entered in a computerised database called PATHAUT. Also entered into PATHAUT is the limited information that is submitted with the organs such as age, ethnic group, the commodity mined and in some cases, the clinical cause of death.

From the PATHAUT database, we produce an annual report in which we display some of the data (Figure 1). The annual report can address some questions – such as the age and population group of the people who are autopsied. Most cases are under the age of 60, they died while working at a mine. Lung disease can develop and persist once miners have retired so a low number of retired miners suggest that there may be barriers to accessing the service and this reveals a referral bias to which we draw attention at the beginning of every annual report[2].

Another question might be – how much disease is there in the mining workforce? Figure 2 shows the rates of lung diseases. It shows that about a quarter of all men examined had active pulmonary tuberculosis. There were also high rates of emphysema and silicosis. If these rates are compared to other published studies, they are seen to be the highest rates of disease in the world for a working population[2,3]. This information raises serious concerns about the South African mining industry. The working conditions that are producing this much lung disease must be excessively dusty.

As well as answering some questions, displaying the data raises new and interesting research questions. Table 1 shows the prevalence of silicosis in gold miners by age. Silicosis should not be found in youngish people who have not had many years of dust exposure. This data suggests that South African mine workers are working in excessively dusty environments. The prevalence of silicosis has increased from approximately 3% in 1975 to 32% in 2010 in black men as seen at autopsy at the NIOH[4].

South Africa is a uniquely mineral rich country. Table 2 shows

Table 1: Number of cases and rate per thousand autopsies, of silicosis in the gold mining industry, by age in 2010.

Age group (years)	Total	
	N	Rate
30-39	8	65
40-49	95	368
50-59	117	485
60-69	36	303
70-79	34	293
80+	17	321
Total	**307**	**327**

Table 2: Number and proportion of autopsies by commodity in 2010.

Commodity	Total	
	N	%
Gold	938	62.5
Platinum	283	18.8
Coal	74	4.9
Asbestos	76	5.1
Iscor	20	1.3
Diamond	13	0.9
Copper	9	0.6
Manganese	16	1.1
Industry	15	1.0
Other	30	2.0
Unknown	28	1.9
Total	**1 502**	

Note: this table shows only those commodities where a total of 9 or more cases were received.

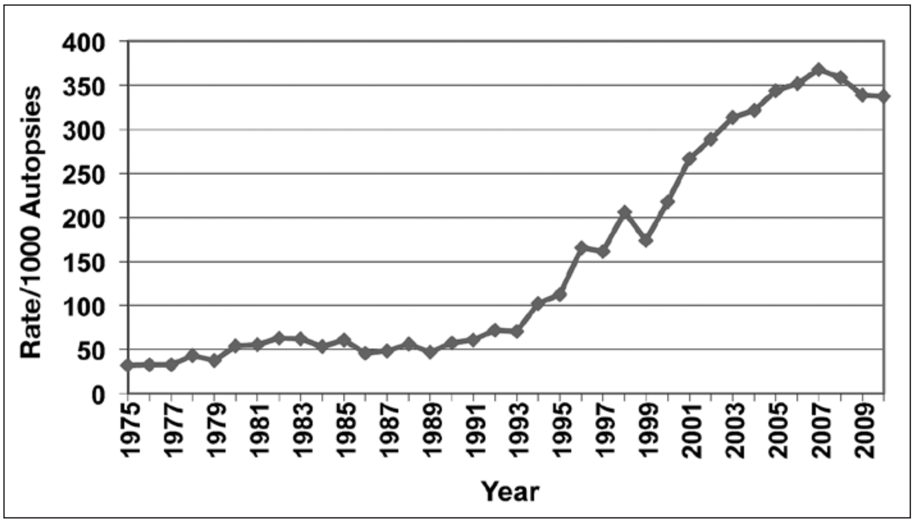

Figure 3: Pulmonary tuberculosis in black mine workers diagnosed at autopsy from 1975 to 2010.

the number and proportion of autopsies performed according to the commodity mined. This is dominated by the two largest mining commodities – gold and platinum. Although manganese mining is on a far smaller scale, South Africa is the world's largest producer of manganese, a mineral that is vital for producing steel. Less than 1% of our autopsies are performed on former manganese miners, but researchers in other countries or institutions might regard 4 cases a year, accumulating year after year, as a good case series[2]. Manganism is a disease due to exposure to manganese. It is clinically similar to Parkinsonism, a disease that is of great interest worldwide. Our data and pathology material has led to the formation of international links and collaborations with prestigious institutions overseas[5]. Your laboratory data and samples may be of great interest to researchers in other countries so it is important to disseminate your reports as widely as possible.

Figure 3 shows data for cases of pulmonary tuberculosis in mine-workers diagnosed at autopsy from 1975 until 2010. There was an increase in tuberculosis from 1975 into the 1980s[4], predating the HIV epidemic and this shows that tuberculosis was a growing health problem in mines even before the HIV epidemic. The PATHAUT database was interrogated to look for an explanation. When the autopsy findings were correlated with clinical information it was found that about 60% of cases of pulmonary tuberculosis had not been diagnosed in life and as a result an intervention was developed to assist clinicians[6]. The escalation in tuberculosis since 1991 reflects the high prevalence of HIV among mine workers and the interaction of HIV and silica in mine dust as a risk factor for tuberculosis[3,7].

In summary, many medical laboratories have the data, the intellectual capacity and hopefully the motivation to undertake the type of research described here. Using routinely collected data will cut down on some of the resources required to undertake research. However, you will need additional dedicated resources of which time is the most important; time to think about the research; time to hold meetings and discussions; time to establish good working relationships with the technical people who will be working alongside you extracting the data and time to produce reports. The rewards can include an improvement in the services provided by your laboratory and advancement in medical knowledge. You will definitely experience greater mental stimulation and job satisfaction.

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REFERENCES

1. Timothy G. An evaluation of laboratory utilization and practices at Chris Hani Baragwanath Hospital: School of Public Health, University of the Witwatersrand. December 2007.
2. Pathaut Reports. NIOH; [Accessed February 2012]; Available from: http://www.nioh.ac.za/?page=pathology_disease_surveillance_reports&id=162.
3. Corbett EL, Churchyard GJ, Clayton TC, Williams BG, Mulder D, Hayes RJ, *et al*. HIV infection and silicosis: the impact of two potent risk factors on the incidence of mycobacterial disease in South African miners. *AIDS*. 2000 Dec 1; 14(17): 2759-68.
4. Nelson G, Girdler-Brown B, Ndlovu N, Murray J. Three decades of silicosis: disease trends at autopsy in South African gold miners. *Environ Health Perspect*. 2010 Mar; 118(3): 421-6.
5. Nelson G, Criswell SR, Zhang J, Murray J, Racette BA. Research capacity development in South African manganese mines to bridge exposure and neuropathologic outcomes. *Neurotoxicology*. 2012 Jan 31; Epub ahead of print.
6. Field N, Murray J, Wong ML, Dowdeswell R, Dudumayo N, Rametsi L, *et al*. Missed opportunities in TB diagnosis: a TB process-based performance review tool to evaluate and improve clinical care. *BMC Public Health*. 2011; 11: 127.
7. Rees D, Murray J. Silica, silicosis and tuberculosis. *Int J Tuberc Lung Dis*. 2007 May; 11(5): 474-84.