Test Power for Drug Abuse Surveillance

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Abstract. Syndromic surveillance can be used to assess change in drug abuse rates and to find regions in which abuse is most common. This paper compares the power of three syndromic surveillance procedures (a paired-sample test, a process control chart, and a conditional autoregressive model) for detecting change in opioid drug abuse patterns, using data from two reporting systems (the OTP and PCC datasets). We find that the conditional autoregressive model provides good power and geographic information and that the OTP data carry the strongest signal.

1 Introduction

The substantial rise in nonmedical use and abuse of prescription opioid analgesics over the past decade offers an important opportunity for comparing syndromic surveillance methods [4]. Prescription drug abuse has similarities to infectious disease due to the inherent geographical effects [3], multiple reporting systems which vary in coverage and data quality, and it is a major concern in public health management. Prescription opioid analgesic abuse cost the U.S. an estimated $8.6 billion in 2001 due to increased health care, workplace, and criminal justice costs [1].

This paper contrasts three different strategies for syndromic surveillance:

- A paired-difference two-sample test, which looks for differences in abuse rates over time at each reporting site.
- A sequential process control procedure, using the CUSUM chart, similar to that used by the CDC [9].
- A conditional autoregressive (CAR) model which incorporates covariates as well as a model for geographic dependence.

These methods are compared with respect to their power in detecting simulated signal using historical abuse data and in their ability to detect hot spots of this abuse.

The data sets used in this study operate under the auspices of the Researched Abuse, Diversion, and Addiction-Related Surveillance (RADARS R⃝) system:

- OTP. The Opioid Treatment Programs study collects quarterly questionnaires from abusers enrolled in Methadone Maintenance Treatment Programs (MMTPs) and thus captures a key population of sophisticated abusers.
- PCC. The Poison Control Center network records information on help calls resulting from intentional drug exposures; not all poison control centers participate, but its coverage is about 70% of the U.S. by population.

Besides these databases we also considered: the National Survey on Drug Use and Health (NSDUH), an annual federal survey; Monitoring the Future (MTF), a nationally representative cohort study of self-reported drug use by 8th, 10th, and 12th grade students, who are then followed in biennial surveys until age 29; and the Drug Abuse Warning Network (DAWN), which provides an annual cross-sectional sample of Emergency Department visits related to nonmedical use of drugs. Although NSDUH and MTF survey 70,000 and 50,000 respondents respectively, the percentage of these individuals abusing opioids is small. Therefore their effective sample sizes for detecting change in a syndromic surveillance program would be inadequate. The effective sample size in DAWN is larger, but DAWN studies only a few major metropolitan areas in the country and therefore spatial information is limited.

We focused on one specific medication, the opioid analgesic OxyContin® (oxycodone HCI, controlled-release) Tablets, since it has been the target of abuse over several years [2]. We focus on change detection for a one-sided alternative which specifies that the drug abuse rate has decreased over time. This approach is simpler than two-sided alternatives, reflects federal interest in measuring the effectiveness of drug prevention programs, and our results extend directly to the symmetric hypothesis that drug abuse has increased.

All power studies were performed by simulation. For each combination of database and analysis, we examined power as a function of simulated levels of abuse reduction. The simulations were performed by bootstrapping [5] from the original data sets, after adjustment to achieve specified reduction levels.

Our goals are to determine the tradeoffs among the three analyses, in terms of power, geographic localization, and operational requirements (computing time, statistical complexity). We also want to determine the tradeoffs among the two databases used in this study. Section 2 describes the methodology; Section 3 presents the results; and Section 4 summarizes the comparisons.

2 Methodology

The methods developed in this paper follow this protocol: 1) a generative model is assumed for the data, 2) simulations with artificial signal are generated from this model, and 3) multiple surveillance techniques are applied to the resulting data. In the OTP data, the generative model is a CAR model including covariates. In the PCC data, the generative model is a log-linear model. In both data sets, the surveillance techniques used include a two-sample test and a process control chart. We also use the CAR and the log-linear model for surveillance in the OTP and PCC data sets, respectively, but the models include a term to detect the difference in abuse between time points.