Review of Economic Analysis

REA Review of Economic Analysis

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Volume 14, numéro 2, 2022

URI : https://id.erudit.org/iderudit/1113809ar
DOI : https://doi.org/10.15353/rea.v14i2.5009

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Éditeur(s)

International Centre for Economic Analysis

ISSN

1973-3909 (numérique)

Découvrir la revue

Citer cet article

Zhou, E. & Bhatia, S. (2022). Cardiovascular Medical Device Failure: Using Five-Week Moving Averages To Assess Adverse Event Report Data. *Review of Economic Analysis*, *14*(2), 335–341. https://doi.org/10.15353/rea.v14i2.5009

Résumé de l'article

The COVID-19 pandemic had a variety of effects on the healthcare system, including the interruption of regular cardiology practices. We examined the pandemic's effects on cardiovascular medical device failure by investigating trends in the number of reports of adverse events of several cardiovascular medical devices over the span of three years, including the first year of the pandemic. Specifically, we used data from the FDA's MAUDE database, calculating the five-week moving average of adverse events associated with both implantable cardioverter defibrillators and coronary drug-eluting stents. We previously reported a 46% decrease in reported deaths attributed to ICDs and a 27% decrease in reported injuries attributed to coronary DES. We use a five-week moving average and confirm a 46% decrease in reported deaths attributed to ICDs, report a 9.8% increase in ICD-attributed malfunctions, and confirm a 27% decrease in reported injuries attributed to coronary DES. The different effects of the pandemic on these adverse event report trends, even within one device, show there are more factors to consider than explanations such as underreporting which would be expected to affect most medical devices relatively homogeneously.

Review of Economic Analysis 14 (2022) 335-341 1973-3909/2022335

Cardiovascular Medical Device Failure: Using Five-Week Moving Averages To Assess Adverse Event Report Data

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The COVID-19 pandemic had a variety of effects on the healthcare system, including the interruption of regular cardiology practices. We examined the pandemic's effects on cardiovascular medical device failure by investigating trends in the number of reports of adverse events of several cardiovascular medical devices over the span of three years, including the first year of the pandemic. Specifically, we used data from the FDA's MAUDE database, calculating the five-week moving average of adverse events associated with both implantable cardioverter defibrillators and coronary drug-eluting stents. We previously reported a 46% decrease in reported deaths attributed to ICDs and a 27% decrease in reported injuries attributed to coronary DES. We use a five-week moving average and confirm a 46% decrease in reported deaths attributed to ICDs, report a 9.8% increase in ICD-attributed malfunctions, and confirm a 27% decrease in reported injuries attributed to coronary DES. The different effects of the pandemic on these adverse event report trends, even within one device, show there are more factors to consider than explanations such as underreporting which would be expected to affect most medical devices relatively homogeneously.

Keywords: cardiology, medical device, adverse event, Covid-19

JEL Classification: I19

Nomenclature

ICD	Implantable cardioverter defibrillator
DES	Drug-eluting stent
FDA	Food and Drug Administration
MAUDE	Manufacturer and User Facility Device Experience database

1 Introduction

With the abrupt switch to remote healthcare or other new practices for cardiologists, and the reliance of post-market surveillance and risk analysis of medical devices on adverse event data, we evaluated adverse event report trends for four cardiovascular devices to better understand the COVID-19 pandemic's impact on healthcare and cardiology.

2 Materials and Methods

We sought to examine adverse event data of the course of three years: March 2018-19, the pre-pandemic year of March 2019-20, and the first year of the pandemic, March 2020-21. The adverse event data we analyzed was from the FDA's MAUDE database, which compiles reports from a variety of parties such as manufacturers and physicians [1] (Food and Drug Administration). Manufacturers are required to report adverse events they are made aware of, whether it be malfunction or death, within thirty calendar days of the manufacturer receiving knowledge of the event. Importers must also report known cases of adverse events within thirty calendar days to both MAUDE and the manufacturer. In certain cases, when the FDA has specified or designated it as such, manufacturers may be required to report an event within five days after the manufacturer is made aware. Over the course of the three years we selected, we examined the number of reports per week for two devices (following names are as shown in MAUDE): 'Implantable Cardioverter Defibrillator (Non-CRT)'and 'Coronary Drug-Eluting Stent'. For each device, we looked at reported rates of the adverse event types 'Malfunction', 'Injury', and 'Death'. We first performed a paired t-test using the number of reports per week for the adverse event, device, and time frame specified. We then took a five-week moving average for each week and performed another paired t-test for our statistical analyses. Our rationale for using a five-week moving average was to reduce white noise and the random variability in data. Our significance level was P-value = .05, and we considered P-value = .01 to be our 'very significant' threshold.

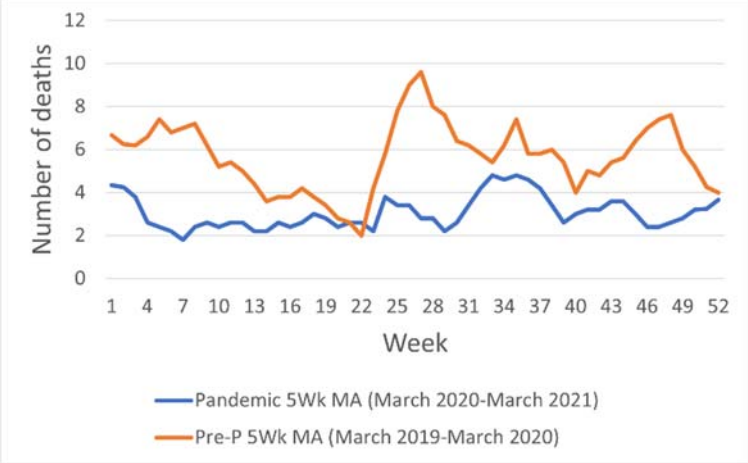
3 Results and Discussion

In examining ICDs, we found previously that there were, on average, 2.6 fewer weekly reports of ICD-attributed deaths during the pandemic than the year prior, or the pre-pandemic year (P-value < .0001), which constituted a drop of 45.8% (Zhou and Bhatia, 2022). We previously also examined if the number of weekly reports changed significantly from the year March 2018-19 to the pre-pandemic year March 2019-20 in order to determine the existence of any pre-existing trends in report data. We found that there were, on average, 1.6 fewer weekly reports of deaths

[1] Food and Drug Administration, "MAUDE – Manufacturer and User Facility Device Experience." www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfmaude/search.cfm.

attributed to ICDs during March 2019-20, a decrease of 22.4% (P-value = .0023). When using a five-week moving average for the paired t-test as opposed to the original number of reports per week, we found slightly different results that were more significant. By using a five-week moving average, we found that there were, on average, 2.6 fewer weekly reports of ICD-attributed deaths during the pandemic than there were in the year before the pandemic, a drop of 46.1% (P-value < .0001) (Figure 1).

Figure 1: Five-week moving average of reported deaths attributed to ICDs, comparing pandemic to pre-pandemic year



When comparing adverse event report data from March 2018-19 to March 2019-20, we found that there were, on average, 1.6 fewer weekly reports of ICD-attributed deaths during March 2019-20 than there were during March 2018-19, a drop of 22.2% (P-value < .0001) (Figure 2).

Our previous results, using original numbers of weekly reports rather than a five-week moving average, indicated that neither ICD-attributed malfunction or ICD-attributed injury report numbers significantly changed during the pandemic. However, when using a five-week moving average, we found that there were, on average, 10.8 more weekly reports of ICD-attributed malfunctions during the pandemic than there were in the year before the pandemic, an increase of 9.8% (P-value = .005) (Figure 3).

We did not find that reports of ICD-attributed malfunctions changed significantly from March 2018-19 to March 2019-20; mean difference [2019 minus 2018] ≈ -8.3 reports, P-value ≈ .09. Similar to the statistical analysis using the original numbers, when using a five-week moving average we did not find a significant change in the number of weekly reports of ICD-attributed injuries during the pandemic; mean difference [pandemic minus pre-pandemic] ≈ 9.9 reports, P-value ≈ .11.

Figure 2: Five-week moving average of reported deaths attributed to ICDs, comparing March 2018-19 to March 2019-20

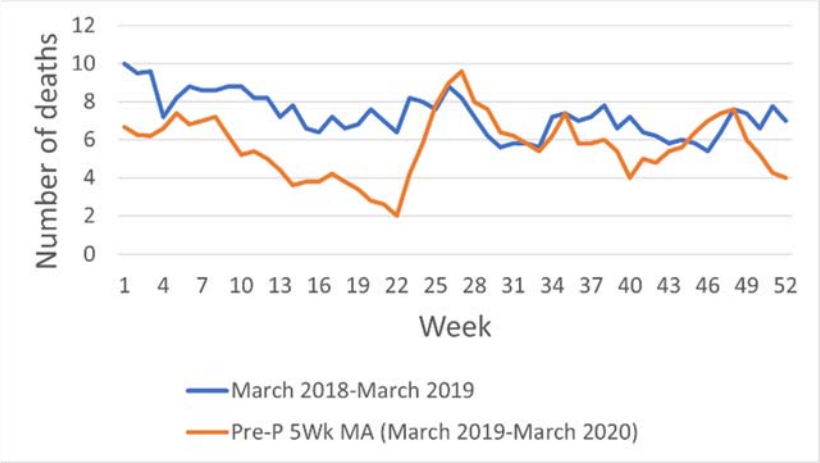
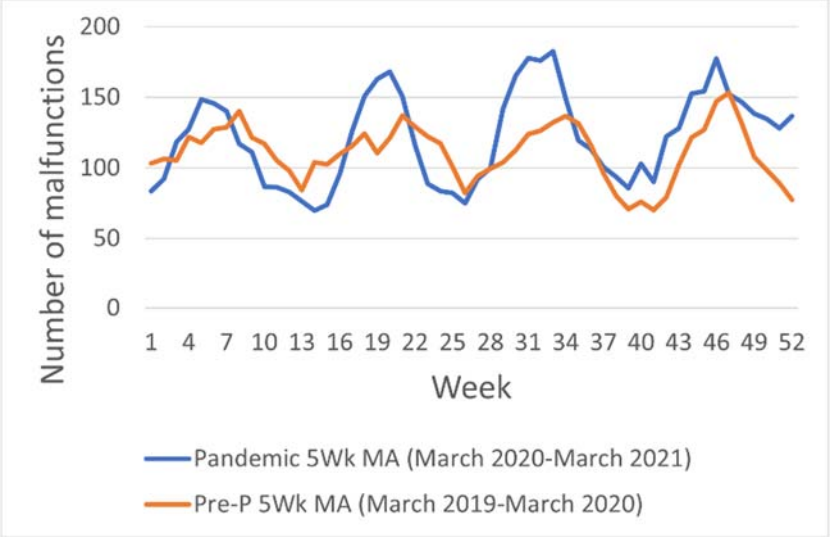


Figure 3: Five-week moving average of reported malfunctions attributed to ICDs, comparing pandemic to pre-pandemic year

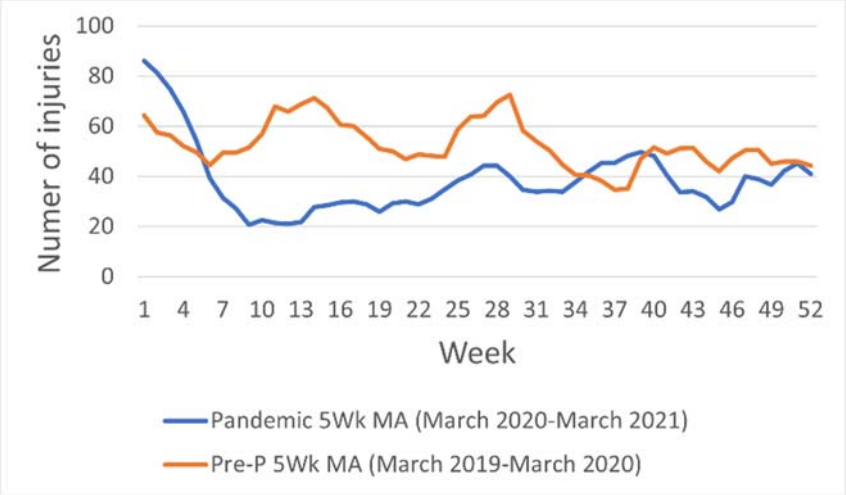


When investigating coronary DES previously, we reported that there were, on average, 14.3 fewer weekly reported coronary DES-attributed injuries during the pandemic than there were in the year prior, a decrease of 27.3% (P-value < .0001).

The comparison between 2018-19 and 2019-20 showed no significant change. When we used a five-week moving average instead of the original data, we found very similarly that there

were, on average, 14.3 fewer weekly reported coronary DES-attributed injuries during the pandemic than in the pre-pandemic year, a drop of 27.1% (P-value < .0001) (Figure 4).

Figure 4: Five-week moving average of reported injuries attributed to coronary DES, comparing pandemic to pre-pandemic year



Also similar to the results of the original data, we found that there was no significant change in reports from 2018-19 to 2019-20 by using a five-week moving average, with a decrease in the average number of reported coronary DES-attributed injuries by 1.2 reports (P-value ≈ 0.45).

Using the original data, we found that reports of coronary DES-attributed malfunctions and deaths did not yield significant results. We found the same results for deaths using a five-week moving average; mean difference [pandemic minus pre-pandemic] ≈ 1.0 reports, P-value ≈ .13. Reports of coronary DES-attributed malfunctions also showed no significant change during the pandemic when we used five-week moving averages; mean difference [pandemic minus pre-pandemic] ≈ -3.0 reports, P-value ≈ .26.

Previously, we identified a variety of explanations for the results of our statistical analyses using the original data, including underreporting, a decrease in implantations overall, or reduced lifestyle stress factors (O'Shea et al, 2021). We noted that while these separate factors had supporting literature, they were all factors that could be reasonably expected to affect or impact the great majority of medical devices similarly. We previously cited a study of 84 different arrhythmia centers in Italy where 92.9% of the 104 physicians surveyed indicated that implantations for ICDs declined significantly during the first few months of the pandemic (Boriani et al., 2020). Along with other studies (Arbelo et al., 2021; Bechlioulis et al, 2021; Pescariu et al., 2021 and Shahabi et al., 2021) this suggested the possibility of an international trend of declining ICD implantations during the pandemic. However, through our statistical

analyses implementing a five-week moving average, all of these factors seem less likely to be the primary reason for the trends seen. This is because for ICD-attributed malfunctions, we found that the weekly report numbers trended upward, or increased by 9.8%, during the pandemic. This suggests that there are other significant factors affecting the adverse event report data because one of our statistical analyses returned a significant increase in reports, contrasting all other results which displayed significant decreases in reports or no significant change.

In addition, the reason for certain variability in our data may come from the process in which data is reported to MAUDE, the thirty-calendar-day time frame and the five-calendar-day time frame, respectively. The range of time available for a manufacturer or other importer to report the event after they are made aware introduces an aspect of variability which is reflected in the graphical representations of the trends observed. However, by using a paired-test analysis for each comparison, and by comparing entire years as opposed to shorter time intervals, we have somewhat countered the variability that could have occurred if we had chosen to use a different statistical test or a shorter period for comparison between pandemic and pre-pandemic. Our use of the five-week moving average also intended to address the natural variability of the adverse event report data and reduce white noise

4 Conclusions

We previously reported that during the first year of the pandemic, reports of ICD-attributed deaths fell by 46% and that reports of coronary DES-attributed injuries decreased by 27%. We confirm both percentages when using a five-week moving average for our statistical analyses, and also report a 10% increase in ICD-attributed malfunctions when using a five-week moving average. The observation that for ICDs, that reports of one adverse event increased during the pandemic while the other decreased, should be further investigated. Further, the explanations previously cited and discussed should be explored in order to better understand how the pandemic has affected cardiology practices, and what physicians need to adjust or be aware of in the future as remote healthcare remains. In addition, as previously stated, post-market surveillance and risk analysis of medical devices often is informed by adverse event data (WHO), so the reliability of adverse event data (which would be negatively impacted by a factor such as underreporting) is important to continually evaluate. Patients and physicians both rely on the accuracy of adverse event data, so confirming its accuracy is vital.

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