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Recruitment of pregnant women to randomised trials of COVID-19 treatments, and pharmaceutical treatments received outside such trials: A research article

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ABSTRACT

Objectives: To document how many pregnant women with COVID-19 reported in the literature had participated in randomised trials, what treatments they received outside such trials and compare the latter with evidence-based treatment recommendations.

Study design: A systematic review of observational studies.

Methods: Two clinical trial registries were searched to identify COVID-19 trials open to pregnant women. Studies were then extracted from a regularly updated list of scientific case reports and case series of confirmed or suspected maternal COVID-19 in pregnancy to identify the number of women enrolled into a trial and the pharmaceutical treatments they received outside such trials.

Results: 156 studies (case reports, case series and registries) reporting 43,185 pregnant women with COVID-19, after de-duplication. Of these 2,671 (6.2%) were potentially eligible for a randomised trial but only seven women (0.26%) were reported to have enrolled.

For 2,839 women the papers included information on treatment received, 1515/2829 (54%) women had received ≥1 treatment and in total a COVID-19 pharmaceutical treatment was administered 1,296 times outside of a trial. In 566 (44%) cases the treatments administered to the pregnant women were not recommended by the National Institutes of Health (NIH) at the time of administration.

Of 179 case reports of women with COVID 19 in pregnancy, 109/179 women received ≥1 COVID-19 pharmaceutical treatment and in total COVID-19 experimental pharmaceutical treatments were administered 274 times.

Conclusion: During the early phase of the COVID-19 pandemic, pregnant women excluded from randomised trials did not avoid unproven or ineffective treatments.

Introduction

The historical exclusion of pregnant populations from clinical trials is not unwarranted. Legitimate ethical concerns surrounding harm to the developing fetus, the complex everchanging physiology of pregnant women, their willingness to participate and special protection bestowed upon them by the rest of society all complicate their recruitment. There may also be concerns surrounding budgeting for unexpected costs of complications and liability in the case of an unwanted outcome [1].

However, the result of not testing in pregnant populations is gradually gaining recognition amongst scientific communities as an equally legitimate ethical concern [2–3]. There has been a shift towards respecting autonomous decision making, encouraging pregnant women to make their own informed decisions about the potential risk of participating in a trial. The absolute number of pharmacokinetic studies has steadily increased over the past 40 years, however the proportion of studies involving pregnant women has been relatively constant since around 1990. This is despite the Institute of Medicine advising that pregnant women should be ‘presumed eligible’ for research participation since 2001. There are exceptions, for example antiretroviral drugs

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are tested in a larger proportion of pharmacokinetic trials including pregnant women [4].

Participation of pregnant women in randomised trials is associated with better health outcomes than for non-participants [5].

The well-documented exclusion of pregnant women from post-marketing evaluations of licensed drugs, and trials of “off-label” use is difficult to justify, if pregnant women are treated outside such trials. We measured the off-label use of experimental treatments for COVID-19 in pregnant women as recorded in published case reports.

Methods

The aim of this study was to document the exposure of pregnant women with COVID-19 to treatments. Firstly, we aimed to identify how many pregnant women with COVID-19 participated in randomised trials. Then we aimed to determine what treatments pregnant women received outside such trials and compare this with treatment recommendations.

RCTs open to pregnant women and the eligibility of pregnant women from case reports, case series and registries.

ClinicalTrials.gov and the ISRCTN trial registry were searched to identify COVID-19 RCTs that were open to pregnant women in October 2020.

Using previously reported search and disambiguation methods [6] from 8 April to 8 November 2020, we identified non-duplicated case reports, case series and registries reporting pregnant or postnatal women with COVID-19. For the seven countries (Nigeria, Republic of Ireland, Denmark, Spain, United Kingdom, United States of America and Canada) where a randomised trial for which pregnant women were eligible to be included was open, we recorded how many women had been reported to have participated in those trials. For each individual study, we checked that there was a randomised controlled trial open to recruitment at the time that the woman received hospital care for COVID-19, in the country where the woman received hospital care. We did not check whether the individual hospital where the woman was receiving care was participating in the randomised controlled trial. For all countries we recorded any reported treatments received outside of any trials. We report totals and results by country.

The first data abstraction from both cases series and case reports was done by OG, assisted by EY, JO, JS, and YK. No formal double data extraction was done but ambiguous papers were reviewed by KW and JT.

Case reports of COVID-19 in pregnancy

Using previously reported search and disambiguation methods [6] from 31 January 2020 to 31 January 2021, we identified non-duplicated case reports of pregnant women with COVID-19, and extracted demographic details, disease severity and what pharmacological treatment (s) was reportedly given.

We identified only case reports to extract more detailed information on pharmaceutical treatments administered to pregnant women as treatments were largely unreported in case series and registries.

This curated list of case reports, case series and registries is listed in Appendix A, and the list of all case reports with duplicates removed in Appendix B.

RCTs open to pregnant women and the eligibility of pregnant women from case reports, case series and registries.

We found ten completed or actively recruiting randomised controlled trials for participants with COVID-19 for which pregnant women were eligible (Appendix C). Five tested pharmacological treatments, and five non-pharmacological treatments.

It was difficult to be sure whether a significant number of cases were duplicated in case series and case reports. We therefore restricted our detailed analysis to case reports (Appendix B).

After removing duplicates, we found 43,185 pregnant women with COVID-19 reported in peer reviewed publications. For 2,241 women sufficient information was given to be clear that they were not eligible to participate in one of the ten trials. In 38,273 cases insufficient details were given to judge eligibility. This left 2,671 pregnant women with COVID where the timing and location suggested that they were potentially eligible due to country of residence and timing to participate in a randomised trial. Of these, seven women were reported to have participated in a randomised trial (Appendix D). No women were reported to have been offered and declined randomisation, or to have participated in any clinical trial outside the ten we identified from the registries. The seven women who participated in a randomised trial participated in two different unnamed trials, one involving remdesivir [7] and one trial of remdesivir versus hydroxychloroquine [8].

The treatments received by women in case series outside of clinical trials

These are detailed in Appendix E. Of 43,185 women COVID-19 pharmaceutical treatments were largely unreported. For 2,839 women in these papers there was information about treatment or not. Among these women, COVID-19 treatments were reported on 1,296 occasions. Of the 1,296/2839 instances reported in the literature, in which pharmaceutical treatments were administered to women outside of a trial, 444 (34%) were hydroxychloroquine, 108 (8.3%) were remdesivir, 76 (5.9%) were lopinavir-ritonavir and 75 (5.9%) were steroids. In 566 (44%) of all cases hydroxychloroquine, lopinavir-ritonavir, darunavir, ritonavir, zinc and tocilizumab were administered. These treatments are not recommended by the National Institutes of Health (NIH) so 44% of pharmaceutical treatments administered were not recommended for COVID-19 at the time of administration [9].

It proved impossible, to extract a clear list of treatments given to individual women from the various case series. We therefore focused on individual case reports. We were able to study these over studies over a longer time period.

Case reports of COVID-19 in pregnancy

We found 179 case reports of pregnant women with COVID-19. Table 1 shows the clinical characteristics of these women.

Table 2 lists the pharmaceutical treatments received by more than five women. Treatments received by fewer than five women are shown in Appendix F.

Table 3 shows the number of women who received the four most popular treatments, chloroquine, remdesivir, corticosteroids and tocilizumab, by country. Since the evidence supports steroid treatment for
severe disease but not for mild we show the number of women given this drug by disease severity in Table 4.

Discussion

Main findings

Of the 2,671 pregnant women with COVID-19 with sufficient details to judge that they were potentially eligible to join an RCT, only seven (0.26%) women were reportedly randomised into a trial.

For 2,839 women the papers included information on treatment received, 1,515/2,829 women had received ≥ 1 treatment and some sort of COVID-19 pharmaceutical treatment had been administered 1,296 times outside of a trial. In 566 (44%) cases the drugs administered to the pregnant women were not recommended by the national COVID-19 treatment guidelines.

Of 179 case reports of women with COVID-19 in pregnancy, 109/179 women received ≥ 1 COVID-19 pharmaceutical treatment and in total COVID-19 experimental pharmaceutical treatments were administered 274 times.

Table 2

| Drug                          | Women who received treatment* n, (%) |
|-------------------------------|-------------------------------------|
| hydroxychloroquine           | 39 (22)                             |
| Antivirals                    | 62 (35)                             |
| Corticosteroids              | 52 (29)                             |
| tocilizumab                   | 8 (4.5)                             |
| convalescent plasma therapy   | 10 (5.6)                            |
| Antibiotics                   | 71 (40)                             |
| Immunoglobulin                | 8 (4.5)                             |
| Interferon                    | 8 (4.5)                             |
| other                         | 16 (8.9)                            |

* Treatments were not mutually exclusive. All treatments that were given to less than 5 women are documented in a supplementary table, Appendix 6. The breakdown of the type of antibiotics, corticosteroids and antivirals used is in supplementary table, see Appendix 7.

Table 3

| Country           | Total mothers N | Hydroxychloroquine | Remdesivir | Corticosteroids | Tocilizumab |
|-------------------|-----------------|--------------------|------------|-----------------|-------------|
| China             | 23              | 0                  | 0          | 11              | 0           |
| USA               | 47              | 14                 | 10         | 14              | 4           |
| Honduras          | 1               | 0                  | 0          | 0               | 0           |
| Sweden            | 3               | 0                  | 0          | 1               | 0           |
| Korea             | 3               | 0                  | 0          | 0               | 0           |
| Turkey            | 7               | 5                  | 0          | 1               | 1           |
| Italy             | 15              | 1                  | 0          | 4               | 0           |
| Portugal          | 3               | 0                  | 0          | 0               | 0           |
| Australia         | 2               | 0                  | 0          | 0               | 0           |
| Canada            | 2               | 0                  | 0          | 0               | 0           |
| France            | 6               | 2                  | 0          | 2               | 0           |
| Peru              | 2               | 1                  | 0          | 0               | 0           |
| Spain             | 3               | 2                  | 0          | 2               | 1           |
| India             | 9               | 0                  | 0          | 0               | 0           |
| Iran              | 13              | 7                  | 0          | 4               | 0           |
| Jordan            | 2               | 1                  | 0          | 0               | 0           |
| UK                | 7               | 0                  | 0          | 2               | 0           |
| Ireland           | 1               | 0                  | 0          | 0               | 0           |
| Belgium           | 1               | 0                  | 0          | 0               | 0           |
| Netherlands       | 4               | 0                  | 1          | 2               | 0           |
| Japan             | 3               | 0                  | 0          | 1               | 1           |
| Brazil            | 5               | 2                  | 0          | 2               | 0           |
| Morocco           | 1               | 1                  | 0          | 1               | 0           |
| Norway            | 1               | 0                  | 0          | 0               | 0           |
| Saudi Arabia      | 1               | 0                  | 0          | 0               | 0           |
| Mexico            | 2               | 0                  | 0          | 1               | 0           |
| Oman              | 1               | 0                  | 0          | 1               | 0           |
| Granada           | 1               | 0                  | 0          | 0               | 0           |
| Switzerland       | 1               | 0                  | 0          | 0               | 0           |
| Thailand          | 1               | 0                  | 0          | 0               | 0           |
| Greece            | 1               | 0                  | 0          | 0               | 0           |
| Pakistan          | 2               | 0                  | 0          | 0               | 0           |
| Venezuela         | 1               | 0                  | 0          | 0               | 0           |
| Iraq              | 1               | 1                  | 0          | 0               | 0           |
| Kyrgyzstan        | 1               | 0                  | 0          | 0               | 0           |
| Romania           | 1               | 1                  | 0          | 1               | 0           |
| Qatar             | 1               | 1                  | 0          | 1               | 1           |
| Total             | 179             | 39                 | 11         | 51              | 8           |
Strengths and comparison with previous studies.

Our findings support previous reports of gross underrepresentation of pregnant women in clinical trials, including COVID-19 trials [10–12]. For example, Taylor et al. identified 124 (80%) trials specifically excluding pregnant women, out of all COVID-19 treatment studies of non-biological drugs [13]. Their study reviewed 10 registries, including the ISRCTN and ClinicalTrials.gov registries assessed in this study. Our findings confirm these reports and extend the findings by determining if pregnant women were eligible to COVID-19 trials and identifying cases where pregnant women were not randomised despite being eligible.

However, we have gone further and shown both that exclusion from trials did not protect women from harmful treatments nor ensure that they got effective ones. For example, chloroquine is now known to be ‘associated with an increased length of hospital stay and increased risk of progressing to invasive mechanical ventilation or death’ [14], but was the drug treatment most often given. No fewer than 444 women out of 2,839 (16%) received it in our larger series. This is likely an underestimate since details of drug treatments were scanty in the larger case series. Among case reports, chloroquine was given to 39/197 (22%) of women. Even this figure is likely to be underestimate.

On the other hand we have also shown that trial exclusion did not mean that pregnant women always got effective treatment. For example more than half of women with severe disease were not documented to have been given corticosteroids. Although this might again be an overestimate due to poor reporting.

Limitations

Much of the primary data for this project consisted of case series and reports to extract more detailed information such as the treatments received. However, case series and reports are subject to bias. There is a lack of uniform reporting as many studies did not report all the variables collected in this study and the reporting was inherently biased by reporting and publication bias. Asymptomatic and mild cases may have been underreported. On top of this, there is the potential for major duplication between registries and case reports and series, for instance the UKOSS reported 100% return from UK obstetric units. It was difficult to be sure whether a significant number of cases were duplicated in case series and case reports. We therefore restricted our detailed analysis to case reports (appendix B).

Implications.

The vast majority of COVID-19 trials identified in this study specifically excluded pregnant women. This exclusion stops the provision of evidence-based care that is representative of all groups of the population. Even trials testing medications endorsed for use in pregnancy exclude pregnant women. A recent search of the 21 online International Committee of Medical Journal Editors (ICMJE) registries and WHO-approved clinical trial registries showed that trials including medications with known safety in pregnancy still routinely excluded pregnant women [13].

Crucially, this study identified the administration of investigational drugs to pregnant women outside the context of a clinical trial. This included ineffective and potentially harmful drugs. When choosing to exclude pregnant women from clinical trials, it should be considered that they may receive the same treatment outside an RCT. They may also receive medications with less evidence to support them, or even evidence against their use. This was demonstrated by the 566 cases of pregnant women who received medications, outside of a trial, that are not recommended by the NIH COVID-19 Treatment Guidelines [9]. So, whilst in many cases the reasons behind their exclusion include potential harm to the fetus or neonate and risk to the mother, counterintuitively, the exclusion of pregnant women does not protect them from harm. The Council for International Organizations of Medical Sciences (CIOMS) published international ethical guidelines in 2016 that specified how to include pregnant women in trials safely and ethically [15]. Trials should aim to follow these principles and justify the exclusion of pregnant women, where applicable.

The Institute of Medicine recommended that pregnant women are ‘presumed eligible’ for participation in research unless evidence proves otherwise, justifications for non-enrolment should be published [16].

Conclusions

The outcomes of this study have highlighted the systematic exclusion of pregnant women from randomised clinical trials, despite large numbers being eligible. Whilst we recognise legitimate concerns regarding potential harm to the fetus, consideration must also be given to the inevitable damage caused by excluding a population from research. Not only does it limit the evidence-base for the safe use of medicines in pregnant women, but it may also lead to the use of ineffective or harmful medications. This study has highlighted the use of COVID-19 pharmacological treatments, administered to pregnant women that are not recommended. We urge those conducting clinical trials to follow the Institute of Medicine recommendations. This will ensure the results can be applied to a larger proportion of the population and inform the safe and effective treatment that pregnant women deserve.

Ethics Approval.

Ethical approval was not required.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] Couderc-Pety M, Elefant E, Wasunna M, Mwingsa NA, Strub-Wourgaft N. Inclusion of women susceptible to and becoming pregnant in preregistration clinical trials in low- and middle-income countries: A proposal for neglected tropical diseases. PLoS Negl Trop Dis 2020; 14(6): e0008140.
[2] Smith DD, Pippen JL, Adesomo AA, Rood KM, Landon MB, Costantine MM. Exclusion of Pregnant Women from Clinical Trials during the Coronavirus Disease 2019 Pandemic: A Review of International Registries. Am J Perinatol 2020;37(8): 792–9.
[3] Bianchi DW, Kaeser L, Cerrich AN. Involving Pregnant Individuals in Clinical Research on COVID-19 Vaccines. JAMA 2021;325(11):1041–2.
[4] McCormack SA, Best BM. Obstetric Pharmacokinetic Dosing Studies are Urgently Needed. Front Pediatr 2014;2.
[5] Nijjar SK, D’Amico ML, Wimalawansa NA, Cooper N, Zamora J, Khan KS. Participation in clinical trials improves outcomes in women’s health: a systematic review and meta-analysis. BJOG 2017;124(6):863–71. 5
[6] Walker KP, O’Donoghue K, Grace N, Dorling J, Comeau JL, Li W, et al. Maternal transmission of SARS-CoV-2 to the neonate, and possible routes for such transmission: a systematic review and critical analysis. BJOG 2020;127(11): 1324–36.
[7] Blitz MJ, Rochelson B, Minkoff H, Meirovitz N, Prasannan L, London V, et al. Maternal mortality among women with coronavirus disease 2019 admitted to the intensive care unit. Am J Obstet Gynecol 2020;223(4):595–599.e5.
[8] Onwuzurike C, Diouf K, Meadows AR, Nour NM. Racial and ethnic disparities in severity of COVID-19 disease in pregnancy in the United States. Int J Gynaecol Obstet 2020;151(2):293-5.

[9] COVID-19 Treatment Guidelines Panel. Coronavirus Disease 2019 (COVID-19) Treatment Guidelines. National Institutes of Health. 2020 [cited 2020 December 4]. Available from: https://www.covid19treatmentguidelines.nih.gov/.

[10] Shields KE, Lytly AD. Exclusion of pregnant women from industry-sponsored clinical trials. Obstet Gynecol 2013;122(5):1077-81.

[11] Pastick KA, Nicol MR, Smyth E, Zash R, Boulware DR, Rajasingham R, et al. A Systematic Review of Treatment and Outcomes of Pregnant Women With COVID-19—A Call for Clinical Trials. Open Forum Infectious Diseases. 2020; 7(9).

[12] Karekar SR, Pooja SG, Marathe PA. A review of clinical studies involving pregnant women registered in the Clinical Trials Registry of India. Perspect Clin Res 2020;11(1):8-12.

[13] Taylor MM, Kobeissi L, Kim C, Amin A, Thorson AE, Bellare NB, et al. Inclusion of pregnant women in COVID-19 treatment trials: a review and global call to action. Lancet Glob Health; 2020.

[14] RECOVERY Collaborative Group. Effect of Hydroxychloroquine in Hospitalized Patients with COVID-19: Preliminary results from a multi-centre, randomized, controlled trial. MedRxiv 2020.

[15] Council for International Organizations of Medical Sciences. International ethical guidelines for health-related research involving humans 2016 [cited 2020 December 29]. Available from: https://cioms.ch/wp-content/uploads/2017/01/WEBCIOMS-EthicalGuidelines.pdf.

[16] Mastroianni AC, Faden RR, Federman DD. Women and health research: National Academy Press Washington, DC; 1994.