# A retrospective cohort study of incidental abdominal aortic aneurysms on routine abdominal computed tomography scans in Te Tairāwhiti (2018–2019)

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## ABSTRACT

**AIM:** Ruptured abdominal aortic aneurysm (rAAA) is associated with a high mortality rate which, is especially significant in rural and provincial regions. In Aotearoa New Zealand, Māori experience higher rates of AAA and worse overall medium-term survival following AAA repair. This study aimed to understand the prevalence of incidental AAA on routine abdominal computed tomography (CT) scans over 12 months.

**METHOD:** A retrospective review of all abdominal CT scans performed on patients ≥50 years at Gisborne Hospital between 1 December 2018–1 December 2019 was performed.

**RESULTS:** A total of 811 scans were reviewed, with 42 incidental AAA detected (5.2%). The majority of incidental AAA were in males aged ≥65 (65.8%), with a higher prevalence for Māori compared to New Zealand European (NZE) (16.2% vs 8.1%, p=0.052). This pattern was also seen in females, aged ≥65 (10.9% in Māori vs 3.8% in NZE, p=0.047).

**CONCLUSION:** The detection of AAA on routine abdominal CT scans appears to be a useful adjunct in lieu of targeted AAA screening in our region. A high prevalence of incidental AAA (5.2%) over 12 months, with a significantly higher prevalence noted in Māori males and females ≥65 years (16.2% and 10.9%), was observed.

Ruptured abdominal aortic aneurysm (rAAA) is associated with a very high mortality rate, which is especially significant in rural and provincial centres where vascular surgical resources are scarce.[1] In Aotearoa New Zealand, it has been reported that Māori experience higher rates of AAA and worse overall medium-term survival following AAA repair.[2–4] Importantly, the majority of studies investigating disparities in AAA prevalence and outcomes following surgical repair for Māori have not yet examined the potential structural issues that may contribute to these ongoing differences.[3,5,6] A pilot AAA screening programme for Māori was performed in the Waitematā and Auckland regions, where Māori comprise approximately 10% of the population in both catchment areas.[2,7] In this pilot study, 2,503 Māori patients were screened, with age-standardised prevalence rates of AAA detected for 3.8% of Māori men and 1.5% for Māori women. Aside from this pilot, targeted screening for AAA has not yet been instituted in Aotearoa New Zealand.

Screening programmes for AAA remain controversial and have been discussed at length in the literature.[8,9] Countries such as the United Kingdom (UK) and Sweden have introduced targeted ultrasound (USS) based screening programmes in patients at increased risk of AAA.[10,11] The United States has also recommended that one-time USS screening for AAA be performed in men aged between 65–75.[12] While Aotearoa New Zealand does not have a national AAA screening programme, it is recommended that opportunistic screening in those at increased risk should be considered; however, this target group is not well-defined.[13] Aside from the obvious fiscal challenges presented when establishing and maintaining a screening programme, Chan et al. (2019) notes that evaluations of AAA screening programmes appear to focus largely on case detection and process measures, without linkage studies examining the possible impacts of a AAA screening programme on overall mortality at a population level.[9] This sentiment has seen recent growth in epidemiological studies reporting the

prevalence of AAA in Aotearoa New Zealand.

Two studies in Aotearoa New Zealand have examined the use of computed tomography (CT) to identify a AAA cohort for surveillance.[14,15] However, the use of CT for AAA screening is neither cost-effective nor feasible in Aotearoa New Zealand. Where there is high clinical suspicion of AAA among New Zealanders, it is most important that healthcare providers factor in that Māori experience AAA rupture at earlier ages, with a standardised mortality rate double that of NZ Europeans (NZE).[3,6]

Te Tairāwhiti (the East Coast) extends from the south border of Te Urewera to the Wharerātā Hills, north of Wairoa, encompassing the iwi boundaries of Ngāti Porou, Rongowhakaata, Ngāi Tāmanuhiri, Te Aitanga-ā-Māhaki and Te Wairoa Iwi and Hapū (Figure 1).[16] Māori comprise 53.5% of the population in Te Tairāwhiti, and thus far no local investigation into AAA prevalence has been conducted.[17] Additionally, Te Tairāwhiti is geographically isolated from its tertiary provider (Te Whatu Ora Waikato), with both inpatient and outpatient vascular services provided out of district, further compromising the outcomes of an acute rupture. As an initial inquiry in Te Tairāwhiti, this study aimed to assess the prevalence of incidental AAA on routine abdominal CT scans performed acutely and electively in Te Tairāwhiti.

## Methods

### Context

Te Whatu Ora Tairāwhiti provides public secondary hospital services to Te Tairāwhiti, serving a population of 49,100. Approximately half of the population identifies as Māori, and two thirds of the population (65%) in Te Tairāwhiti live in areas of high deprivation.[17] As such, health outcomes for the people of Te Tairāwhiti reflect some of the poorest in Aotearoa New Zealand with minimal understanding of equity in access to surgical services in Te Tairāwhiti.[18,19] The Department of Surgery of Te Whatu Ora Tairāwhiti is based at Gisborne Hospital, a rural hospital of 110 beds, providing General Surgical, Orthopaedics and Otorhinolaryngology (Ear, Nose and Throat) surgical services. With no vascular surgeons in Te Tairāwhiti, minimal vascular surgical services are able to be provided in Te Tairāwhiti. Where patients require major acute or elective vascular

**Figure 1:** Iwi boundaries of Te Tairāwhiti (acquired from Te Puni Kōkiri).[16]

surgical care, on-referral to Waikato Hospital, a tertiary centre 377 kilometres away, is necessitated. Urgent patient transfers to Waikato Hospital are provided by a local flight team.

### Design and participants

A retrospective cohort review of all routine abdominal CT scans performed on patients at Te Whatu Ora Tairāwhiti between 1 December 2018–1 December 2019 was performed in line with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist and guidelines. The eligible population included patients aged ≥50 years who had an abdominal CT scan performed at Gisborne Hospital over the previously defined study period. Eligible patient national health index (NHI) numbers were identified by a local hospital data analyst and retrieved from the picture archiving and communication system (PACS). Exclusion criteria included abdominal CT scans ordered for planning of AAA management and follow-up, abdominal CT scans of poor image quality and abdominal CT scans where the infrarenal aorta was not entirely visualised. Patients who had multiple scans during the time period were analysed at the point of their last scan during the time period. This study was approved by the Hauora Tairāwhiti Ethics Committee (2020/Memon).

### Variables

Data were collected with the key variables of interest being patient demographics (age, sex, comorbidities and ethnicity), indication for abdominal CT scan and AAA diameter. The slice of each CT scan demonstrating the largest maximum diameter of the infrarenal aorta on the axial plane was visually identified on PACS and thrice magnified in the field of view. These slices were measured using the electronic callipers tool. All measurements were taken from the outer adventitia to the directly opposite outer adventitia, with the line of measurement passing through the centre of the aortic lumen. All eligible scans were measured on PACS first by one author (RK) and then again by a second author (JM) to ensure accuracy. These measurements were analysed for inter-observer consistency with a Bland–Altman plot comparing aortic measurements. Infrarenal aortas with measured diameters ≥30mm were diagnosed with an AAA.[13] Where disagreement between the two measurers occurred, on aortic measurement ≥10mm or at the 30mm cut-off for a AAA, adjudication by a third measurer (SM) was employed. Accompanying radiologist reports were also analysed to determine if AAA were reported, and whether appropriate recommendations were made for ongoing surveillance and referral. Clinical records for patients with an incidental AAA were reviewed by a consultant general surgeon (SM) regarding clinical relevance. The diagnosis of an AAA was deemed clinically irrelevant if a patient was thought not to benefit from surveillance or be a suitable candidate for surgical intervention. This occurred in the context of advanced age, frailty, multiple comorbidities and metastatic disease. Data were last collected 11 August 2023 and patient outcomes reported retrospectively (i.e., deceased and cause for death).

### Statistical analyses

Descriptive statistics were collated, and Wilcoxon Rank-Sum tests or Student's *t*-Tests were used to compare continuous variables between demographic groups, with Fisher's *t*-Tests and Chi-squared tests used for categorical data. The association between age and incidence of axial AAA was analysed using logistic regression. Analysis was performed in R (4.0.0) and JASP (0.16.2). Results were considered significant at $p<0.050$.

### Responsiveness to Māori

This research was performed in accordance with the Te Ao Māori Framework to ensure a non-deficit and anti-racist approach to research involving Māori and, specifically, Māori data.[20] Given that Māori comprise nearly half the population of Te Tairāwhiti and that recent research has reported that Māori experience higher prevalence of AAA and higher rates of mortality after AAA repair, it was important that this study had local Māori oversight (J-LR and AM) to ensure that this research is responsive to Māori from and residing in Te Tairāwhiti.[21]

## Results

### Eligible patient cohort demographics

A total of 1,100 abdominal CT scans were performed in patients ≥50 years at Gisborne Hospital over the study period. Figure 2 shows the flow of patients from the eligible population through to the final number of patients included and excluded in this study. The final eligible cohort consisted of 811 patients, with a median age of 68 years (range 50–99) at the time of scanning. This cohort was predominantly male (52.3%) and NZE (62.6%), with a mean (sd) axial aortic diameter

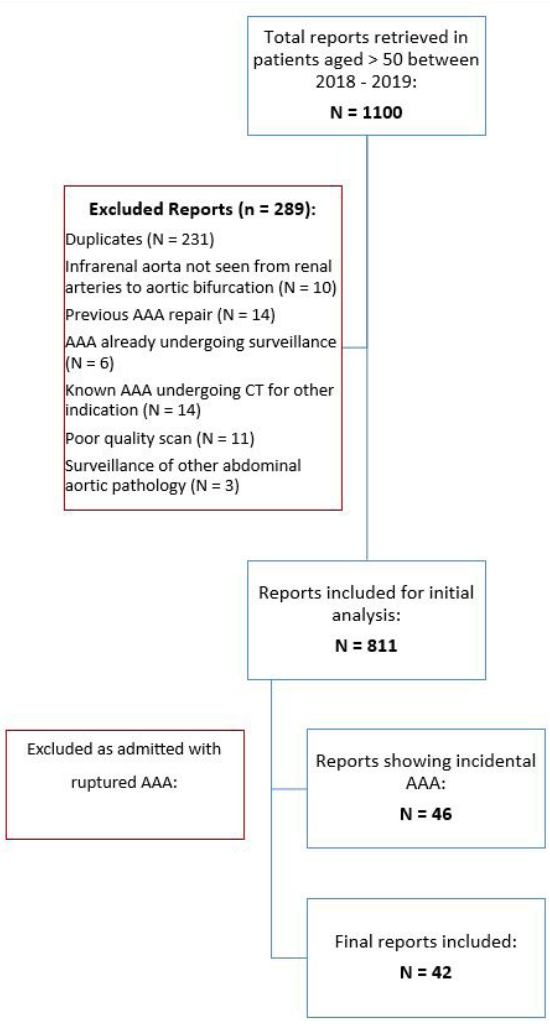
of 22.2(4.5)mm (range 13.3–100.2). Furthermore, four patients were admitted with a ruptured AAA over the study period, with one transferred to Waikato for AAA repair and the remaining patients palliated at Gisborne Hospital.

## Incidental AAA patient demographics and outcomes

Incidental AAA were detected in 42 patients via CT imaging, yielding a total prevalence of 5.2%. The prevalence was higher in males, in comparison to females (7.1% cf 3.1% p=0.011), and for every year of age increased by 4%, OR (95% CI) 1.04 (1.00, 1.09), p=0.024. Abdominal CT scans requested for acute indications were also noted to have significantly higher rates of AAA compared to elective CT scans (8.2% cf 3.5% p=0.004). Most patients were males aged ≥65 (69.2%), with Māori experiencing a higher prevalence than NZE patients (16.2% cf 8.1% p=0.052). Similarly, a significantly larger proportion of Māori females aged ≥65 were diagnosed with incidental AAA compared to their NZE counterparts (10.9% cf 3.8% p=0.047). Over 55% (N=23) of patients resided in areas of high deprivation (New Zealand Index of Deprivation [NZDep] 2018 score 8–10) and eight patients lived rurally, with an average distance of 155km from Gisborne Hospital.

Thirteen (30.9%) patients had their incidental AAA reported in the final report. This was associated with size, as all AAA >40mm were reported by radiologists, but only 9.3% of AAA measuring 30–40mm were reported (p<0.001). There was no significant difference in AAA reporting rates for gender, age, ethnicity and acuity. Upon review of patients' clinical records, 18/42 (43%) were deemed

**Figure 2:** Flowchart of incidental AAA diagnosed in Te Tairāwhiti (2018–2019).



to be clinically relevant. The identification of an AAA in the remaining 24 patients was considered not to confer a clinical benefit primarily due to advanced age (37.5%) and multiple comorbidities (42.7%). This appeared to be affirmed by the high number of deaths observed over the next 4 years due to non-AAA related events.

### Inter-observer measurement bias

Diagnostic accuracy between the two measurers was confirmed with an acceptable κ index statistic of 0.91 and a Bland–Altman plot demonstrating that the majority of measures lay within the 95% confidence intervals.

## Discussion

This study presents an initial inquiry into the prevalence of incidental AAA in Te Tairāwhiti for patients presenting for routine abdominal CT scans. Of 811 abdominal CT scans that met the criteria for inclusion in our study, 42 patients had an incidental AAA, conferring an overall prevalence of 5.2% in our 12-month study period. In this period, four patients presented with a ruptured AAA, with one patient transferred to Waikato Hospital for surgical intervention. This specific study arose due to our observation of recent studies examining the prevalence of AAA, opportunistic screening and outcomes following AAA repair for Māori. As Te Tairāwhiti has the highest proportion of Māori residing in this region, we wanted to investigate incidental AAA detection on routine abdominal CT scans over a 12-month period.

Population-based studies reporting the prevalence of AAA in Māori remain scarce. However, epidemiologic studies of AAA hospitalisation and mortality have reported that Māori experience higher rates of AAA hospitalisation and mortality compared to NZE people in Aotearoa New Zealand.[3,5,6,22] Sandiford et al. (2019) measured population prevalence of AAA in Māori men and women in the Auckland Region and reported a high prevalence of undetected AAA among Māori, with men experiencing rates 2–3 times higher than current prevalence rates in screened male European white populations in the UK and Sweden.[2] Our study revealed an overall incidental AAA rate of 5.2%, which was higher than the aforementioned study. In addition, Māori experience hospitalisation for AAA at 1.5 times that of NZE patients, with an age-standardised mortality

**Table 1:** Initial eligible patient demographics.

| Characteristic | Total (N) | Prevalence of AAA, N (%) |
|---|---|---|
| **Sex** | | |
| Male | 424 | 30 (7.1) |
| Female | 387 | 12 (3.1) |
| **Ethnicity** | | |
| NZE | 508 | 24 (4.7) |
| Māori | 285 | 18 (6.3) |
| Other | 18 | 0 |
| **Acuity of CT scan** | | |
| Elective | 518 | 18 (3.5) |
| Acute | 293 | 24 (8.2) |
| **Age** | | |
| <65 | 329 | 3 (0.9) |
| ≥65 | 482 | 39 (8.1) |

**Table 2:** Incidental AAA patient characteristics and outcomes at 4 years.

| | **AAA Size** | | |
|---|---|---|---|
| | **30–40mm** | **40–50mm** | **>50mm** |
| **Total incidental AAA, N (%)** | 36 (86%) | 5 (12%) | 1 (2%) |
| **Reported by radiologist (%)** | 4 (9.4%) | 5 (100%) | 1 (100%) |
| **Acuity of scan** | | | |
| Acute | 18 | 1 | 1 |
| Outpatient | 18 | 4 | 0 |
| **Gender, N (%)** | | | |
| Female | 11 | 2 | 0 |
| Male | 25 | 3 | 1 |
| **Ethnicity, N (%)** | | | |
| NZE | 22 | 3 | 0 |
| Māori | 14 | 2 | 1 |
| **Comorbidities** | | | |
| HTN | 26 | 4 | 1 |
| T2DM | 10 | - | - |
| Hyperlipidaemia | 17 | 2 | - |
| **CCI score** | | | |
| Mean (range) | 6 (2–14) | 5 (3–6) | 6 (6) |
| **NZDep2018 score,* N** | | | |
| 1–4 | 7 | - | - |
| 5–7 | 8 | 4 | - |
| 8–10 | 21 | 1 | 1 |
| **Rurality** | | | |
| Rural | 6 | 2 | - |
| Mean (range) distance from Gisborne Hospital (km) | 38 (0.5–271) | 15.4 (1.8–132) | 5.8 (5.8) |
| **Ever smoked** | | | |
| Yes | 28 | 3 | - |
| No | 8 | 2 | 1 |

**Table 2 (continued):** Incidental AAA patient characteristics and outcomes at 4 years.

| **Median follow-up time from CT scan (years)** | 4.2 | 4.3 | 3.7 |
|---|---|---|---|
| **Mortality outcomes** | | | |
| Deceased | 17 | 3 | 1 |
| AAA-related cause of death | - | - | - |
| **Surveillance** | | | |
| Active surveillance | 1 | 2 | - |
| Referred to vascular Waikato | 2 | 1 | - |
| Not under surveillance before institution of referral pathway in 2020 | 24 | - | - |

*NZDep2018, deprivation score where 10 = high deprivation and 1 = low deprivation.
AAA = acute aortic aneurysm; CCI = Charlson Comorbidity Index; HTN = hypertension; T2DM = type 2 diabetes mellitus; NZE = New Zealand European.

rate approximately double that of NZE patients.[3] Khashram et al. (2017) showed that Māori had higher rates of deprivation (low socio-economic status), but regardless of this, Māori still had worse overall medium-term survival following AAA repair.[4] This study further showed that socio-economic status and Māori ethnicity were markers of increased exposure to risk that negatively impact upon survival after AAA repair. These dire statistics that face Māori in terms of prevalence of AAA and perioperative mortality, accompanied with a higher rate of incidental AAA on routine abdominal CT scans, support the need for early intervention and screening for AAA. This is especially indicated in Te Tairāwhiti, where Māori comprise more than half of the population and rates of socio-economic deprivation are among the highest in Aotearoa New Zealand.

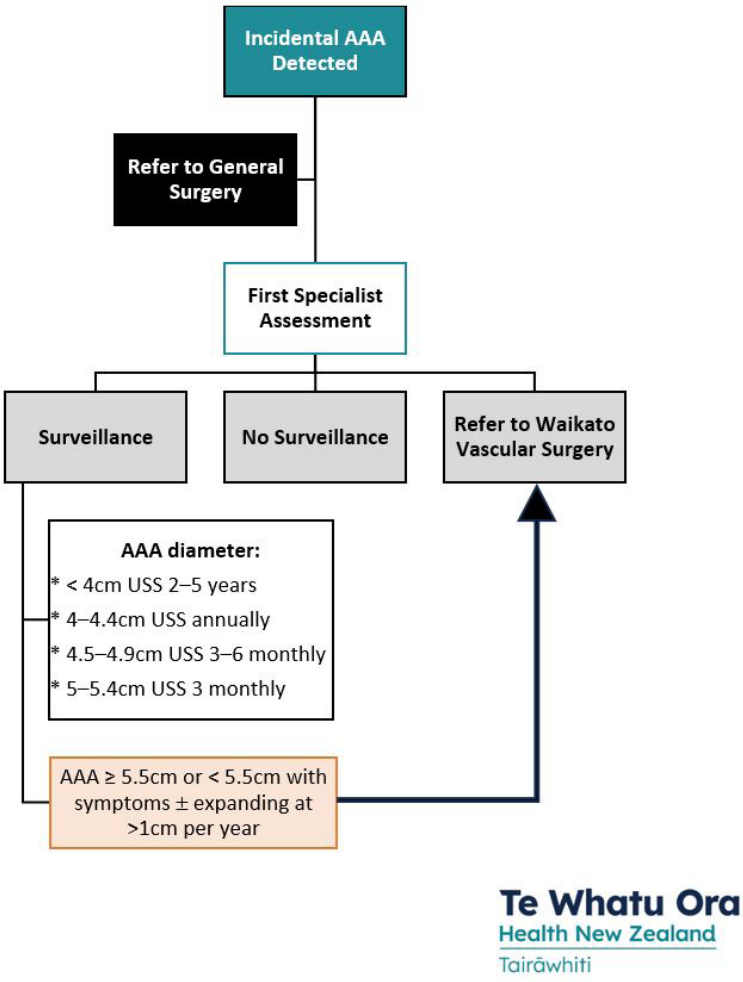
Regarding opportunistic CT measurement of AAA, one study reported an AAA prevalence of 5.8% in routine abdominal CT scans in people aged ≥50, and the second reported a prevalence of 6.1% in CT colonography for men aged ≥55.[14,15] The AAA prevalence for all patients in this study was also higher than that in targeted screening programmes. An AAA prevalence of 4.4% was reported in Aotearoa New Zealand patients aged ≥50 years with increased cardiovascular risk, while the prevalence in the UK's national screening programme was 1.2%.[23,24] The higher prevalence in our study may be partially explained by the inclusion of patients that had a symptomatic AAA as the reason for their CT, as detection of an AAA in these cases is not incidental. However, the majority of AAA in this study were incidental (90.5%) and unrelated to the primary diagnosis. A higher prevalence of AAA in Māori men and women aged ≥65 years compared to NZE patients was observed. In Te Tairāwhiti alone, the use of CTs has increased 46% since 2015, with similar findings in other Aotearoa New Zealand hospitals.[14] The increasing numbers of CT scans being performed will continue to improve the utility of CT for detection of incidental AAA. Opportunistic detection of AAA on CT as a method of population screening has several advantages. Firstly, it focusses on at-risk cohorts not traditionally targeted by screening programmes, such as females, who are often thought to be low risk.[25] Our study demonstrated a 3.1% prevalence of AAA in females, which is higher than rates of AAA in most targeted screening programmes, with rates of prevalence ranging from 0.7–1.8%.[25,26]

Perhaps the most notable finding in our study was the high prevalence of AAA in Māori women ≥65 years (10.9%). This is relevant in the context of female AAA outcomes, with research demonstrating a faster growth rate and three times greater likelihood of fatal rupture in comparison to males.[25] Another advantage of this method of AAA

identification is the economy of resources in implementation. Due to its opportunistic nature, no recruitment or imaging costs are required. In addition, it does not rely on high patient adherence to implement, which is often a major barrier to the success of screening programmes. In order to optimise identification of AAA on routine abdominal CTs, improvements in reporting AAA are needed. Although AAA ≥40mm were reliably read, 90.3% of AAA <40mm were not reported. This was likely due to the large number of small borderline aneurysms around the cut-off of 30mm. The reliance on visual recognition of enlarged aortas to prompt measuring of the aorta with electronic callipers likely accounted for the majority of these overlooked AAA. As suggested by others, we recommend a lower size threshold for visual recognition prompting earlier use of electronic callipers for objective measurement.[14] In the future, computerised reporting of CT scans and synoptic reporting may increase the incidental diagnosis of AAA. In addition, a greater awareness of the 30mm cut-off defining an AAA and defined institutional pathways to clarify responsibility for ongoing management are required to facilitate ongoing surveillance.

There are several limitations to this study. Firstly, the retrospective design, as well as the limited 12-month period of observation, considerably limits the strength of this study. The purpose of this study was to inspect and amend our local processes in regard to incidental AAA diagnoses and how they are managed in Te Tairāwhiti. We also acknowledge that the implications of detecting AAA in patients are far more complex than deciding if they will benefit from repair by reviewing the medical records, and that patients with aneurysms should have their risk factors and cardiovascular assessment performed. Lastly, we acknowledge that we have utilised the traditional

**Figure 3:** Incidental AAA referral pathway Te Tairāwhiti.[27]



size criteria for diagnosis and treatment of AAA and note that others have suggested these criteria be revisited, particularly for females.[25]

In conclusion, the detection of AAA on routine abdominal CT scans appears to be a useful alternative or adjunct in lieu of targeted AAA screening in our region. This study revealed a high prevalence of incidental AAA in the Te Tairāwhiti population (5.2%) over 12 months, with a significantly higher prevalence noted in Māori males and females ≥65 years (16.2% and 10.9%) compared to their NZE counterparts (8.1% and 3.8%). Given the findings of this study, and that our people in Te Tairāwhiti face some of the highest levels of deprivation, as well as having the highest proportion of Māori in Aotearoa New Zealand, we have advocated for and established a formal referral pathway for patients who have incidental AAA diagnoses made on routine imaging for other indications (Figure 3). Alongside this pathway, we advocate for formal AAA screening to be undertaken in our region for the same reasons our incidental AAA referral pathway was instituted.

**COMPETING INTERESTS**
Nil.

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