
Hospital Topics

Urinary tract infection in children

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Abstract

During 1968-77, 572 consecutive children with one or more positive urine cultures who were referred by their family doctors to one paediatric surgical outpatient clinic were investigated and prospectively recorded. An abnormality requiring treatment was found in 45%. The yield of positive findings and need for operation were greater in those referred after one infection than in those with recurrent infection. Among those under 2 years old 90% had an abnormality. One third of children with vesicoureteric reflux showed renal scarring at the time of first attendance.

The results of medical and surgical treatment over five to 15 years of follow up were analysed. They emphasised the importance of culturing the urine whenever there may be urinary infection in a child and of investigating immediately those with a positive urine culture.

Introduction

Infection of the urinary tract during infancy and childhood has been studied extensively both by screening healthy populations¹ and by analysing the findings in children referred to specialist centres.² Individual general practitioners, however, see relatively few children with urinary tract infection: one practice of 7000 patients saw about 10 a year.³ It is therefore difficult to build up a picture of the range and incidence of the abnormalities

found in children who present to their family doctor with a urinary tract infection, and opinions on when and how to investigate them vary.

Some 80 000 children under the age of 13 live in the Grampian region of Scotland and are served by a single children's hospital. For 20 years general practitioners have been encouraged to submit a midstream specimen of urine to the excellent regional postal laboratory service whenever a child is suspected of having urinary tract infection and to refer any child with a positive culture to the Royal Aberdeen Children's Hospital for investigation. A substantial but unselected proportion of the children consequently referred to the hospital have been seen in one outpatient clinic, and a complete prospective record of each of these children has been kept since 1967.

The aims of the study were twofold. The first was to record the results of the investigation and treatment of the 572 children, all under 13, who were seen at the clinic for the first time during 1968-77. The second was to maintain a long term watch on their progress. This paper gives the results of the investigations and the outcome for each child over the five to 15 years after they were first seen.

Methods

All children resident in the Grampian region with a history of at least one confirmed urinary tract infection who had been referred by their family doctor to one paediatric surgical outpatient clinic were registered; a proforma was completed and updated over the years. All the proformas were abstracted during 1982-3 and checked against the case notes. Follow up was facilitated because all case records in this hospital are transferred to the files of the Royal Infirmary when children reach 13, and the patients continue to be seen in our adult surgical outpatient clinic. Patients were normally seen every six or 12 months (on 90% of occasions by PFJ) until they had been free from infection and asymptomatic for six to 12 months. When there were positive findings (especially ureteric reflux) we continued follow up indefinitely. Nineteen were lost to long term follow up.

The policy of the clinic was to carry out as full an investigation as

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seemed appropriate at the first attendance, and 550 children (96%) underwent intravenous urography, 500 (87%) micturating cystourethrography, and 386 (67%) cystoscopy on that occasion. Almost all investigations were performed as outpatient day care procedures; 99% of the cystoscopies were carried out by one surgeon (PFJ). Radionuclide scanning was also used when indicated.

Results

Table I shows the number of children presenting at each age. Only 6.6% presented during the first two years of life and only one third were seen before they were 5. Girls preponderated at all ages except under 2. Table II shows that the younger the child the greater was the likelihood of finding an abnormality. Intravenous urography performed on 550 children showed an abnormality in 187 (34%). Five hundred children underwent both intravenous urography and micturating cystourethrography, and an abnormality was found in 292 (58%) (51% of all patients).

TABLE I—Age at presentation and sex of 572 children with confirmed urinary tract infection

	No of children presenting at ages (years):												Total	
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12		12-13
Girls	11	5	26	46	48	48	46	47	44	16	37	16	9	399
Boys	14	8	9	13	17	24	15	23	16	6	12	7	9	173
Ratio of girls to boys	1:1.2	1:1.6	1:0.3	1:0.2	1:0.4	1:0.5	1:0.3	1:0.5	1:0.4	1:0.4	1:0.3	1:0.4	1:1.0	1:0.4

TABLE II—Abnormal findings on investigation in different age groups

	All patients	Children under 5	Infants under 2
Total	572	197	38
No (%) showing abnormal result on IVU and MCU	292 (51)	114 (58)	34 (90)

IVU = Intravenous urogram. MCU = Micturating cystourethrogram.

Cystoscopy was carried out when there was a suspicion of bladder abnormality or of ureteric reflux, when the aim was to correlate the appearance of the orifices with the degree of reflux. Cystoscopy was performed on 386 children and an abnormality found in 168 (44%), the main findings being either abnormally patulous orifices or cystitis cystica. Radiological reflux occurred through 8% of orifices that looked normal and did not occur through 12% of patulous orifices.

Figure 1 shows the final diagnoses reached after completion of

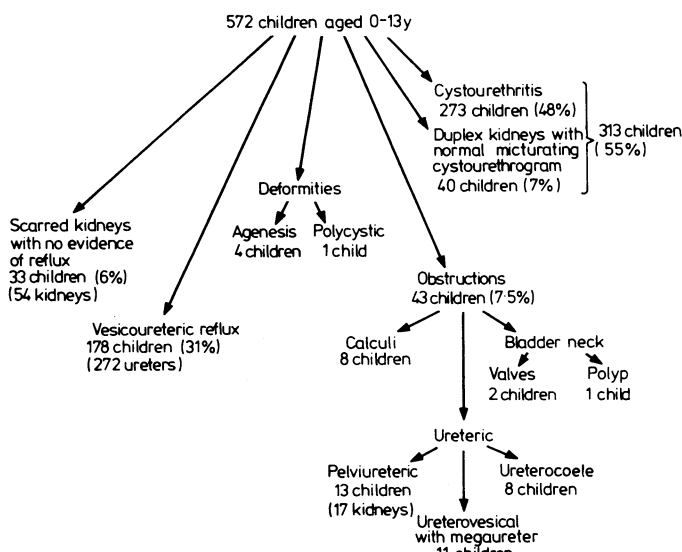


FIG 1—Final diagnosis in 572 children aged 0-13 with confirmed urinary tract infection.

these investigations. Table III compares the results of investigation of children who attended after their first confirmed urinary tract infection with the results in those who came after two or more attacks.

TABLE III—Results of investigations of children with one urinary tract infection compared with those of children with recurrent urinary tract infections (figures are numbers (%) of children with abnormalities)

	Single urinary tract infection	Repeated urinary tract infections
Total No of patients	164	408
Positive culture of MSU at first consultation	67 (41)	97 (23)
Abnormal IVU	65 (40)	130 (32)
Abnormal MCU or MCU and IVU	88 (54)	204 (50)
Surgery required	58 (35)	91 (22)

MSU = Midstream specimen of urine. IVU = Intravenous urogram. MCU = Micturating cystourethrogram.

“CYSTOURETHRITIS”

In almost half the children (273 (48%)) no abnormality could be found on investigation except that they had had a confirmed urinary tract infection. While recognising that some of these children might have had intermittent mild ureteric reflux, we thought it reasonable to believe that basically they had an ascending infection limited to the bladder, which we termed “cystourethritis.” In addition to these 273 children, a further 40 had a duplication of one or both collecting systems but the micturating cystourethrogram was normal and there was a single normal ureteric orifice. These children behaved in a similar way to those with cystourethritis, so 313 children (55%) can be regarded as coming within one group, and their subsequent progress is shown in fig 2. Boys constituted one third (31%) of this

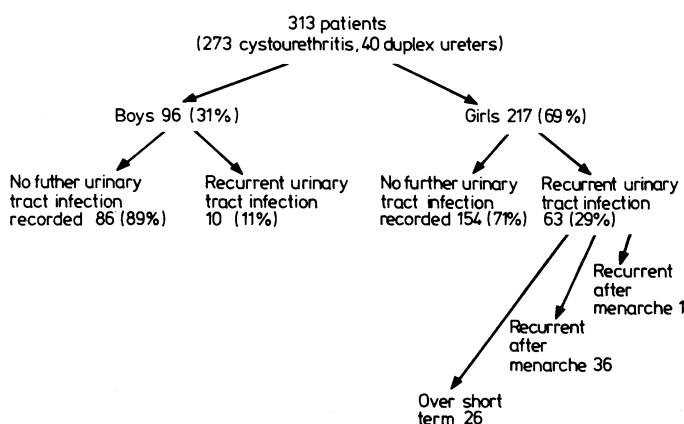


FIG 2—Outcome in 313 patients with proved urinary tract infection but otherwise normal investigations.

group, and recurrences occurred in 11% compared with 29% of the 217 girls. Of these 63 girls, 37 suffered repeated attacks, although only one continued to do so after the menarche: all received courses of low dose long term prophylactic chemotherapy (usually cotrimoxazole or nitrofurantoin, but occasionally nalidixic acid) according to the sensitivities of the bacteria. Many of these courses continued for a year or more, and no major side effects were seen in this group or in the children having medical management of ureteric reflux. Recurrence of symptoms during treatment was due to the

emergence of a resistant organism: we found no condition among these children equivalent to the abacterial cystourethritis of adults. Follow up visits continued until the child was free of symptoms.

URETERIC REFLUX

Vesicoureteric reflux was seen in 178 children (31%) and in 272 ureters (figs 1 and 3). Three grades of reflux were recognised: grade 1 in 37%, grade 2 in 32%, and grade 3 in 31%. Management followed a fairly uniform plan over the 10 years. Those with grade 3 reflux and wide open golfhole ureteric orifices were generally operated on in the belief that reflux was unlikely to remit spontaneously. With grade 2 reflux in younger children considerable attention was paid to the appearance of the ureteric orifice. If it appeared normal then medical management was used, but if a child under 5 (sometimes extended to 8) had an orifice that looked abnormal and a normal intravenous pyelogram, an operation was preferred in the hope of preserving a normal kidney and eliminating the need for years of medical treatment. We were encouraged in this view by our knowledge of the efficacy and freedom from complications of the advancement operation.⁵

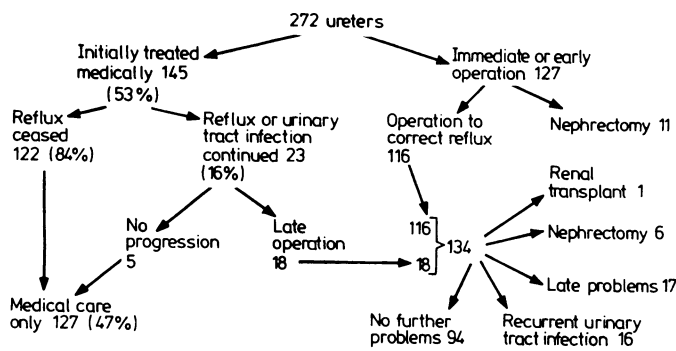


FIG 3—Treatment and outcome in 178 children with ureteric reflux shown in 272 ureters.

Figure 3 shows the outcome of the decisions made for the 272 ureters showing vesicoureteric reflux. Almost all children given medical treatment received long term low dose chemotherapy: at first sulphafurazole (Gantrisin) was used, but most received cotrimoxazole (about 2 mg trimethoprim/kg/day). Nitrofurantoin and nalidixic acid were used as indicated by the sensitivities of the bacteria. Although 20% of the kidneys in children treated medically showed signs of reflux nephropathy at the start of treatment, only one example of progressive scarring was seen on follow up. In 84% of these children reflux had resolved when checked by a later micturating cystourethrogram. Initially 145 (53%) of the ureteric abnormalities were treated medically, but later 18 of them showed radiological signs of deterioration or there was particular difficulty in controlling infection so they were treated by operation. Finally, 145 (53%) of the 272 ureters were operated on for correction of reflux (figs 3 and 4): the advancement operation was used in 101, and 33 dilated ureters were treated by Politano-Leadbetter reimplantation (table IV). Seventeen ureters showed deterioration after operation to correct

TABLE IV—Results of operation to correct ureteric reflux in 134 ureters by ureteric advancement (101) or Politano-Leadbetter reimplantation (33)

Results	Ureteric advancement operation	Politano-Leadbetter reimplantation
IVU normal before and after operation	44	5
Renal scarring present before operation, unchanged afterwards	41	15
IVU normal before operation, scarring afterwards	2	1
Caliceal distension or deformity before operation, returning to normal afterwards	12	2
Recurrence of reflux in postoperative IVU	2	7
Ureteric obstruction in postoperative IVU		
Renal scarring before surgery, followed later by:		
Deteriorating function	2	2
Nephrectomy	2	4
Ureterostomy		2
Bilateral drainage into ileal conduit		2

IVU = Intravenous urogram.

reflux (figs 3 and 4). Four children developed hypertension, which was relieved by nephrectomy in two and medical treatment in two. Progressive dilatation was seen in seven ureters after Politano-Leadbetter reimplantation: all were re-explored, four successfully, but three required later conversion to ureterostomy. Four children in whom one kidney became non-functional required nephrectomy. One child who presented with severe reflux nephropathy died in renal failure two years after operation, and one patient (now aged 20) has recently undergone renal transplantation.

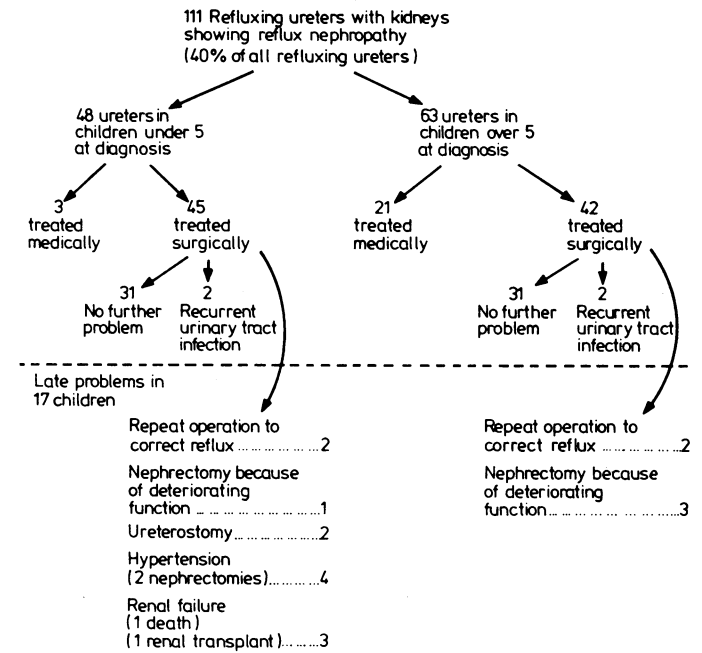


FIG 4—Treatment and outcome in 111 refluxing ureters in 102 children who had scarring of kidney at time of diagnosis.

Long term follow up of the 101 ureteric advancement operations did not show any case of ureteric obstruction, and only two ureters showed continuing mild reflux, which later resolved (table IV).

Recurring symptomatic cystourethritis is a problem in one fifth of children after successful operations to correct reflux and has often required long term low dose chemotherapy. A continuing review of 90% of patients with ureteric reflux in the adult outpatient clinic, however, showed that very few girls suffer from cystourethritis after the menarche.

Nephrectomy was required on presentation in 11 children because reflux nephropathy had progressed to complete or nearly complete loss of function: eight total nephrectomies and three heminephrectomies were performed.

RENAL SCARRING WITHOUT REFLUX

On investigation 33 patients were found to have scarring in 54 kidneys but no evidence of ureteric reflux: six were aged under 2. Follow up showed that 21 did not, and nine did, have further urinary tract infection, but there was no evident deterioration in the scarred kidney(s), except in three children whose scarring led to loss of function: nephrectomy was performed and these patients remained well.

PRIMARY OBSTRUCTION OF THE URINARY TRACT

In 43 patients there was organic obstruction in the urinary tract (fig 1); in 13 there were 17 kidneys with obstruction at the ureteropelvic junction, and in 11 there was primary megaureter due to obstruction of the ureterovesical junction. All were treated by operation (pyeloplasty or excision of the lower ureter and reimplantation). Eight children with single or bilateral ectopic ureterocolles were treated by excision of the cyst and partial nephroureterectomy. Six of 39 kidneys were, or became, non-functional and were removed.

Eight children with severe calculous disease required clearance of renal, pelvic, and ureteric stones, and two partial nephrectomies were required. One girl with distal renal tubular acidosis and bilateral staghorn calculi was treated successfully with alkalis for some years after stones had been cleared from both kidneys, but later progressive renal failure led to her becoming one of our two patients to proceed to renal dialysis and later transplantation: three years later she remained well. In the seven other children the urine was kept sterile and stone formation did not recur.

Only one child had posterior urethral valves, one underwent successful repair of an anterior urethral valve, and one boy had bladder neck obstruction due to a posterior urethral polyp, which was readily removed.

CHILDREN IN THE FIRST TWO YEARS

There were 38 children aged under 2 (22 boys, 16 girls), 35 of whom had a major abnormality: 13 had ureteric reflux, six had renal scarring without demonstrable reflux, and 12 had treatable obstruction of the ureters or the neck of the bladder. Few of these infants had complaints directly referable to the urinary tract. The abnormalities were discovered when children who were feverish or generally unwell had urine taken for culture.

LONG TERM RESULTS

Our policy has been to follow up each child for as long as seemed advisable. We have aimed to see each child with cystourethritis every six months until they have been asymptomatic and free of infection for about a year: this has often meant seeing them over several years. The aim among all the children with reflux and those who required surgery for any reason has been to follow them up indefinitely to gain information about the long term effects of their condition.

The results of this follow up are shown in table IV and in figs 2, 3, and 4. There have been relatively few late complications. Recently two children with reflux and megaureters, who were treated by ureterostomy as infants, have had operations to correct the reflux and closure of the ureterostomies. Apart from the two children requiring transplantation in early adult life, no one has required dialysis, although one youth of 15 is likely to require it in the near future.

Discussion

There are many published reports on urinary tract infections in childhood, but it remains difficult to define the results of a policy of prompt investigation of all children found by general practitioners to have a proved urinary tract infection and to know what happens to them in the long term. The Grampian region of Scotland has a single children's hospital, with close links with general practitioners, and this has made possible the present survey, which we believe was reasonably unselected. Most of the children were referred with a history of frequency and dysuria. These are not complaints that indicate reference to a surgical rather than a medical clinic, so fig 1 probably gives a fair picture of the findings if all children with a positive urine culture are investigated.

It is important to recognise that all children with symptoms suggestive of urinary tract infection do not, in fact, have an infection. In Melbourne 804 children with suspicious symptoms had a urine specimen carefully collected by their general practitioner, but only 125 (15%) yielded a positive culture.⁶ Dickinson had a similar experience.⁷ When 116 of the 125 were investigated, however, 36 (31%) were found to have a radiological abnormality, so the importance of acting on a positive culture is clear: 45% of our children had an abnormality requiring treatment.

There is still controversy over the timing of investigation, and Potts and Irwin recently found that 78% of 125 general practitioners questioned believed that girls should have had repeated infections before it was justifiable to refer them to hospital for investigation.⁸ Our results (table III), however, clearly show an advantage in investigation after the first con-

firmed urinary tract infection. This is particularly underlined by the fact that 35% of patients infected for the first time required an operation compared with 22% of the patients with recurrent infection. In 1973 Bailey strongly advised full investigation after the first urinary tract infection,⁹ and this point should be emphasised in student and postgraduate teaching because urinary tract infection is relatively unusual in general practice.

The age at which children are referred is of great importance (table II). In our patients aged under 2, 90% had an abnormality, and this was true for 58% of those under 5. Clearly, the earlier that urinary tract infection can be detected the better, but it is essential to remember that urinary tract symptoms are inconspicuous in children under 2 and not specific (for example, failure to thrive, fever, vomiting, and refusal of feeds).¹⁰

The questions must be asked whether we have overinvestigated our patients and whether the workload of sending to hospital all children who have an initial urinary tract infection would be excessive. It is true that 80% of our patients with cystourethritis had only had one episode of urinary tract infection, but we cannot emphasise too strongly that there is no way in which children with major urinary tract disease can be identified except by investigation—3 year olds with grade 3 reflux can look as healthy as their brothers and sisters.

If it is accepted that every child with one proved episode of urinary tract infection should be investigated, what should be done? We now always aim to carry out intravenous urography. Cavanagh and Sherwood argued that if there is no detectable abnormality in the intravenous pyelogram and ureterogram grade 3 reflux can be excluded and micturating cystourethrography is not needed.¹¹ This may be true, but the question remains whether we should remain in ignorance of grade 2 reflux.¹²

We have come to place considerable reliance on the value of outpatient cystoscopy, which, with the help of a consultant paediatric anaesthetist, gives useful information and creates less disturbance than micturating cystourethrography. Dunn *et al* had a similar experience.¹³ We now confine micturating cystourethrography to patients with abnormal pyeloureterograms or abnormal ureteric orifices or a history of loin pain and fever.

Figure 2 shows the long term outcome in patients who had no demonstrable abnormality. One third had trouble with recurrent cystourethritis, but none had renal damage. They required long term prophylactic low dose chemotherapy,¹⁴ and we can confirm the value and safety of this treatment in controlling recurrence of cystitis.

Opinions now vary widely on the use of operations to correct reflux,^{15 16} with a pronounced recent swing away from the use of surgery.¹⁷ The decisions in this series were all taken six or more years ago, and we still think that it was sound to use an operation to correct reflux in those under 5 with grade 3 reflux. We also often chose operation for children under 5 who had grade 2 reflux with a cystoscopically patulous orifice, on the principle that one micturating cystourethrogram does not guarantee that grade 3 reflux does not occur, and that very prolonged medical treatment is needed for these children. We have also used advancement in children with bilateral vesicoureteric reflux when one kidney already showed reflux nephropathy and we were keen to protect the other kidney, which looked normal. The proved safety of advancement^{5 18} helped in making this decision.

A total of 272 refluxing ureters was found in 178 children, and similar numbers were chosen for medical and surgical treatment. Although 111 of 272 kidneys showed reflux nephropathy at the time of diagnosis, only 17 (6.5%) developed major problems, none being in the group treated by advancement. The incidence of hypertension and of late nephrectomy was low. The only death from renal failure occurred in a girl who came to us with fairly advanced bilateral reflux nephropathy. There is, however, no cause for satisfaction when more than one third of our children with vesicoureteric reflux already had signs

of renal scarring when they presented (111/272 (40%) kidneys). This is largely due to the fact that fewer than 7% of the children referred were under 2, and only 34% under 5, and it is during these early years that damage occurs. The screening of all healthy infants for urinary tract infection does not seem feasible, so the strongest possible encouragement must be given to making cultures of the urine of any infant who might have such infection. This report shows that nearly half of those with a positive culture will have an appreciable abnormality, and provides the clearest justification for investigation after the first proved urinary infection.

We thank Mr A M Stewart FRFR, FRCSEd for carrying out almost all the radiological investigations and for the great contribution made by his skill and enthusiasm. ND-L received financial support from the research subcommittee of the Grampian Health Board during the abstraction of the records. We are deeply indebted to Miss Marion Fordyce and Mrs Morag Bustin, who kept the records up to date and gave us such willing help throughout the investigation.

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MATERIA NON MEDICA

Iolaire

Iolaire was launched on 14 April at Tarbrush Bottom in Whaler Bay on Galiano Island. Galiano Island is one of the Gulf Islands, and the gulf is the Gulf of Georgia which lies between the coast of British Columbia's mainland and Vancouver Island. *Iolaire* is a sixteen foot version of the Shetland sixern and she has been built with traditional care and, one can say, with reverence also. Her finish is pine tar and linseed oil; only the oars are varnished. She is clinker built of yellow cedar and she has two unstayed masts with fixed lugsails, tanned of course.

The naming was nothing pretentious and it was done by pouring a jug of water and wild flowers over the bow. A garland of blue and yellow blossoms hung from the stem as she slid down the tramway to the blue, cedar fringed waters of the bay in brilliant sunshine to the "Sons of Glencoe" played on the great highland bagpipe.

Once afloat, *Iolaire* rowed as easily as a skiff. The Scandinavian heritage of these Shetland boats is clear. Sixerns were often rowed to the fishing grounds, far from sight of land. *Iolaire* will, of course, sail whenever the wind is right or the voyage a long one. Nevertheless, four oars will pull her around the Gulf Islands, up the coast, and into the incomparable inlets of the Inside Passage to Alaska on many a windless day. Such, at least, is our hope and intent.

The builder, his wife and daughters, the new proud master, wife, and sundry wellwishers piled into *Iolaire* and a handy Norse rowing boat after the launching ceremony and all rowed to York Island at the mouth of the bay for a picnic in the evening sun and to watch sealions sporting in the calm waters of the Gulf. *Iolaire* lay at anchor admired by all and admiring her own reflection in the darkening waters as the mast tops caught the last of the setting sun.

Iolaire: some may wonder at our using this name which has sad and tragic memories for Lewismen and other Hebrideans. A naval yacht of that name sank, almost within sight of Stornoway harbour, with many returning servicemen aboard at the end of what I still think of as the Great War, an Cogadh Mor. But *Iolaire* means eagle: this is no *Titanic* or *Lusitania* of a name. The earlier *Iolaire* sank when she was overcome by the elements, a storm on the Minch. This was neither an ignominious nor a dastardly end, though a sad one. Eagles still fly, however, and they are very common in these parts. There are few bays or beaches where the eagle cannot be seen, majestic and beautiful, soaring aloft in the blue and gold of high summer or fall. They belong here if they belong anywhere. This new eagle has a right, therefore, to her name in these waters. Failte do'n Iolaire.—KENNETH MACRAE LEIGHTON, Vancouver, Canada.

"And I remember Spain"

I belong to a generation that can still be stirred by memories of the tensions and passions aroused by the Spanish civil war. There was then a painful awareness that the forces of evil in the human guise of Franco, ably assisted by those other Princes of Darkness, Hitler and Mussolini, were in the ascendant, and that if they were not stopped the whole of Europe would be engulfed in the obscenity that was being perpetrated.

I was conscious of the ensuing devastation of Spain itself and of the cost in terms of the lives and limbs of millions of men and women, among whom I could count personal friends who had had the courage to translate idealism into action and volunteer to join the fight against fascism. What I had, for some inexplicable reason, not realised was the grim fate that awaited the untold thousands of combatants taken prisoner by Franco; until, that is, I was enlightened by a particularly well informed and politically conscious guide during a bus tour of Gomera.

Gomera, one of the tiniest of the inhabited Canaries, is, like the rest of the "Fortunate Isles," volcanic. Topographically, it consists of a spectacular mixture of forbidding, barren crags—the highest reaching nearly 5000 feet—and lush, cultivated, terraced valleys. The peculiarities of the terrain were responsible for the social isolation of groups of inhabitants and the difficulties of communication between them. As a result, a uniquely fascinating language, the "whistling language" (silbo), was evolved to facilitate hilltop to hilltop communication. Silbo is not just a method of transmitting signals—the vocal analogue of the semaphore, so to speak—but a sophisticated language whereby words and sentences are represented by tones and rhythms whistled with or without the use of fingers in the mouth. The volume of the sound produced can be ear piercing.

But, as our guide was at pains to point out, this has all changed; and the change was brought about by the use, or abuse, by Franco of a section of his prisoners of war. They were employed, it appears, as slave labour to build a system of roads on the island; a daunting task achieved at what cost in blood, sweat, and tears one shudders to think.

As a result of this magnificent feat of engineering the need for the "whistling language" has declined rapidly, so that the few practitioners who remain use their skills solely for the entertainment of tourists, and a most impressive performance it is, to be sure. But even if silbo does disappear completely the new roads will remain as a monument in perpetuity to the utility of war and to the indomitable spirit of man.—HENRY R ROLLIN, Honorary Librarian, Royal College of Psychiatrists, London.